NARRATIVE END ITEM REPORT

SATURN S-IVB-212

DOUGLAS MISSILE & SPACE SYSTEMS DIVISION

MCDONNELL DOUGLAS
CORPORATION

SEPTEMBER 1968

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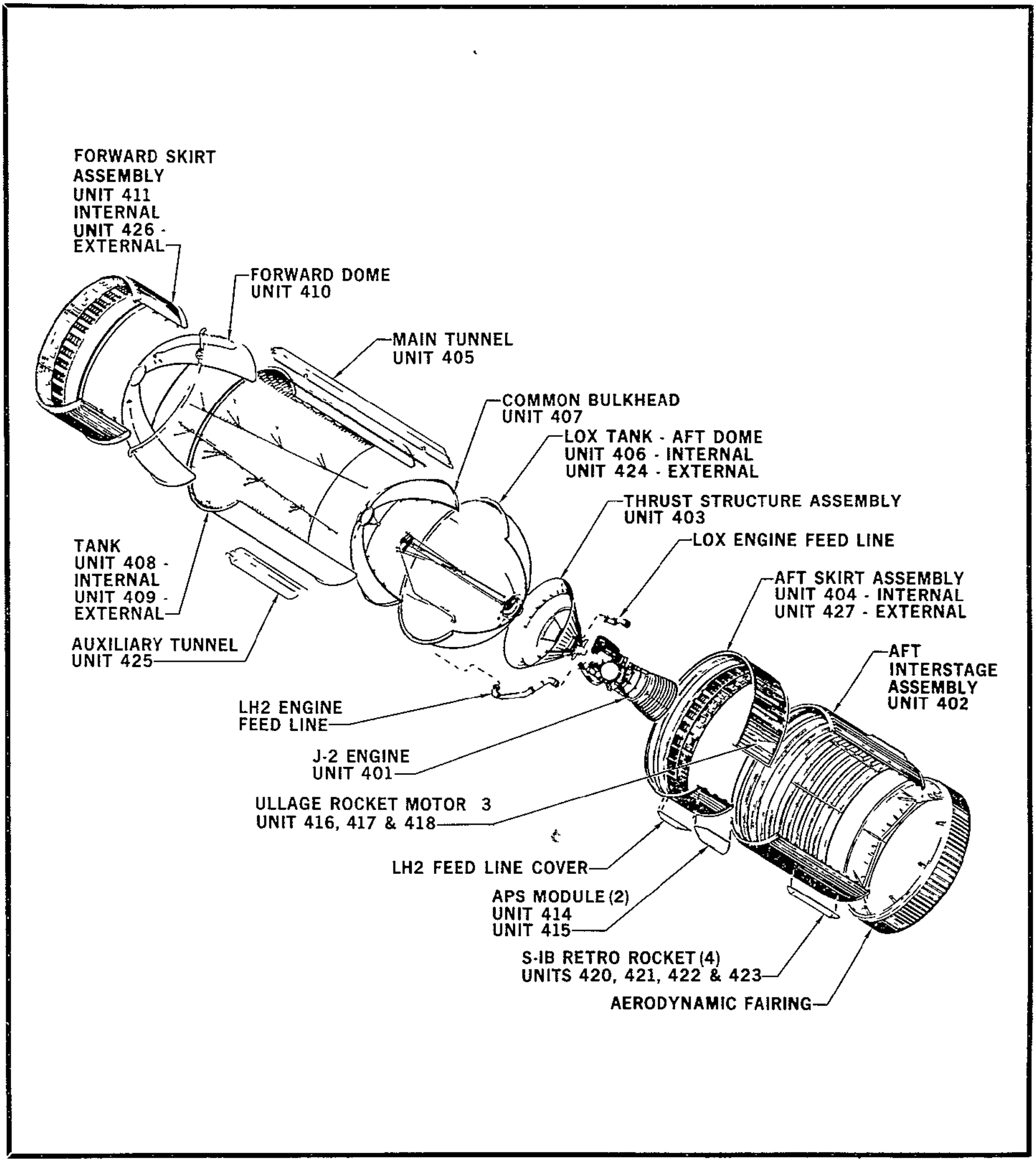

Exploded View of S-IVB Stage for Saturn IB

ABSTRACT

The Narrative End Item Report contained herein is a narrative summary of the McDonnell Douglas manufacturing and Space Systems Center test records relative to the Saturn S-IVB-212 Flight Stage (Douglas P/N 1A74633-521, S/N 2012).

Narrations are included on those conditions related to permanent nonconformances which were generated during the manufacturing cycle and existed at the time of Space Systems Center acceptance testing. The report sets forth data pertinent to total time or cycle accumulation on time or cycle significant items. Data relative to variations in flight critical components is also included. There is no provisions to update or revise the NEIR after initial release.

Descriptors

NEIR	Significant Items
Documentation	Stage Checkout
Configuration	Manufacture and Test

PREFACE

This Narrative End Item Report is prepared by the Reliability Assurance Directorate of McDonnell Douglas Astronautics Company (MDAC), Western Division, for the National Aeronautics and Space Administration under Contract NAS7-101. This report is presented in response to requirements of NPC 200-2, paragraph 14.2.4, and is issued in accordance with MSFC-DRL-021, Contract Data Requirements, which details the contract data required from MDAC. The report summarizes the period of initial stage acceptance testing at the MDAC Space Systems Center, Huntington Beach, California, and transfer to MDAC Sacramento Test Center (STC), Sacramento, California.

The period of stage testing at STC, and turnover to the Florida Test Center (FTC), Cape Kennedy, Florida, will be covered by the subsequent Narrative End Item Report, Saturn S-IVB-212, Douglas Report DAC-56582.

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SECTION 1

INTRODUCTION

1.0 INTRODUCTION

1.1 Scope

The NEIR compiles quality evidence and assessments of a particular end item for use in evaluating program objectives and end item usage. This report narrates upon the Saturn S-IVB Stage and discusses the following:

a. Configuration at transfer to Sacramento Test Center.

b. Replacements made during Space Systems Center test and acceptance checkout, including the serial number of articles removed or substituted.

c. Nature of problems and malfunctions encountered.

d. Corrective action taken or pending.

e. Extent of retests or tests not completed.

f. Total operating hours or cycles for each time or cycle significant item.

1.2 Format

This document is organized into sections, with each section fulfilling a specific purpose. The title of each section and a brief outline of its purpose follow:

SECTION:

1. INTRODUCTION. This section discusses the scope of the NEIR, the Stage Design Concept, and Documentation.
2. NARRATIVE SUMMARY. A brief discussion of the principle test areas is presented to give management personnel a concise view of successful test achievement, and remaining areas of concern.
3. STAGE CONFIGURATION. Conformance to engineering design, and data on time/cycle significant items.
4. NARRATIVE. A presentation of checkout operations presented in the chronological order of testing. Failure and Rejection Reports (FARR's) are referenced as applicable for each paragraph.
5. POSTRETENTION. A presentation of transfer data, stage configuration, additional stage testing prior to shipment (if any), final inspection, weight and balance, preshipment purge, retest requirements, post-checkout FARR's, and flight critical items installed at shipment.

APPENDICES:

I. TESTING SEQUENCE. Graphic presentation of the order and activity dates of the VCL checkout procedures.

1.2 (Continued)

II. NONCONFORMANCE TABLES.

a. TABLE I. A compilation of FARR's against structural assemblies.

b. TABLE II. A compilation of FARR's recorded during systems installation and checkout.

1.3 Stage Functional Description

A detailed system analysis is beyond the scope of this report. The "S-IVB-IB Stage End Item Test Plan", 1B66532, contains a description of each operational system, and includes a listing of test procedures, with the objective and prerequisite of each test. The stage is primarily a booster stage consisting of propellant tanks, feed lines, electrical and pneumatic power for operation of stage systems, and such systems as are required for checkout purposes, fuel loading and unloading control, in-flight control and pressurization, and data measurement during these operations.

1.4 Documentation

Manufacturing and test records for this stage include Fabrication Orders (FO's), Assembly Outlines (AO's), Inspection Item Sheets (IIS's), Failure and Rejection Reports (FARR's), Serial Engineering Orders (SEO's), Radiographic Inspection Records, Hydrostatic test data, Vehicle Checkout Laboratory (VCL) test data, and vendor data. FO's and AO's record in sequence all manufacturing processes, procedures, and Quality Control inspection activities. Any problem or discrepancy noted by Inspection and Test personnel is recorded on an IIS for corrective action. Any discrepancy from a drawing requirement is recorded on a FARR by Inspection and Test personnel. The FARR is also used to record the Material Review Board (MRB) disposition applicable to the discrepancy. SEO's may be written to define the rework required by a FARR; to change the effectivity of a drawing; or to change other drawing requirements. Radiographic Inspection Records and X-ray photographs of all weld seams are maintained on file by the contractor. All original data is retained in the contractor's Reliability Assurance Department Central Data Files. Vendor technical data is received on functional purchased parts and also retained in Central Data Files. The majority of documentation referenced within this report is included in the log book which accompanies the stage.

SECTION 2

NARRATIVE SUMMARY

2.0 NARRATIVE SUMMARY

The following paragraphs present a narrative summary of manufacturing and checkout of the stage. Stage manufacturing tests and stage checkouts conducted at the Space Systems Center (SSC) are summarized in paragraphs 2.1 and 2.2, respectively, while paragraph 2.3 summarizes the post-checkout propellant tanks leak check. Narrations on these tests and operations are presented in section 4.

Paragraph 2.4 comments on the preparations for stage retention at Huntington Beach.

2.1 Stage Manufacturing Tests

Two major manufacturing tests conducted on the stage during the manufacturing sequence verified the structural integrity of the stage propellant tank assembly. A hydrostatic proof test, successfully conducted on 8 and 9 March 1967, verified that the tank assembly could withstand the required test pressures, without major leakage or damage. One minor leak encountered during this test was corrected to a satisfactory condition.

The propellant tank leak check conducted between 14 and 17 March 1967, ensured that there were no leaks in the weld areas nor where the tank assembly wall was penetrated by lockbolts or other types of fasteners used to attach structural items to the tank assembly.

At the conclusion of these tests the tank assembly was accepted for continued manufacturing effort and system installation. A more detailed narration of these tests is presented in paragraph 4.1.

2.2 Stage Checkout SSC

The stage was installed in SSC VCL tower 6 on 29 June 1967. Checkout of the stage systems started on 25 July 1967, and was completed on 14 September 1967, after 37 working days of activity. A total of 33 checkout procedures involving the stage systems were accomplished during this period. The stage was removed from the VCL on 18 September 1967. Narrations on the checkout procedures are presented in paragraph 4.2, in the order in which the tests were started. Appendix I shows the chronological sequence of the tests, giving

2.2 (Continued)

the narration paragraph number, the H&CO drawing number and test title, and the dates each test was active.

Prior to turning on the stage power, checks were made of the stage wiring continuity and compatibility, the forward skirt thermoconditioning system, the engine alignment, and the cryogenic temperature sensors. No major problems were encountered, and no FARR's were written, although several procedure revisions were made. A second issue of the engine alignment procedure was accomplished later, as noted below. The aft skirt and interstage thermoconditioning and purge system, and the telemetry and range safety antenna systems, were checked, and the umbilical interface compatibility check was accomplished. Several procedure revisions were made, but no problems were encountered and no FARR's were written.

Power was first applied to the stage on 1 August 1967, with the initiation of the stage power setup and turnoff procedures. No major problems were encountered, although several malfunctions occurred on the first attempts, and several procedure revisions were required. During subsequent use of the power setup procedure as a preliminary to other automatic tests, two FARR's rejected and replaced the DP1-BO multiplexer, P/N 1B62513-533, and a relay module, P/N 1A74211-505. These FARR's, and other FARR's noted below, are summarized in the applicable narrations and in Table II of Appendix II.

The signal conditioning setup and the level sensor and control unit calibration were both completed with no major problems, although a number of procedure revisions were required. One FARR during the latter procedure rejected and replaced a control unit, P/N 1A68710-511. Two issues were required to complete the digital data acquistion system (DDAS) calibration procedure. The first issue was accomplished with some minor problems and numerous procedure revisions. Two FARR's were written during this issue, to reject and replace the PCM/DDAS assembly, P/N 1A74049-511, and to adjust the VCO output of the newly installed unit. The second issue of the procedure was required to test the replacement DP1-BO multiplexer, and only the multiplexer tests were repeated. No problems were encountered, although again several procedure revisions were made.

2.2 (Continued)

Six manual leak checks were performed in parallel with the remaining system tests, to locate and correct any leakage in the stage pneumatic and pressurization systems. Revisions were made to these procedures as necessary. The propulsion component internal leak check was completed with no problems and no FARR's. The fuel tank pressurization system leak check was completed after a FARR corrected one leak at an umbilical disconnect. The pneumatic control system leak check located and corrected several leaks, and three FARR's rejected and replaced the pneumatic power control module, P/N 1B43657-509, and the engine pump purge control module, P/N 1B56804-1. The cold helium system leak check located and corrected several minor leaks, and two FARR's were written to reject and replace orifice fitting, P/N 1B63046-515, and to rework pipe assembly, P/N 1B58807-1. The propellant tanks system leak check was satisfactorily completed after two minor leaks were corrected, with no FARR action required. The J-2 engine system leak check located six leaks. Two of these were corrected without FARR action, while one FARR was written to correct the remaining four.

The propulsion system control console test was completed with no problems, FARR's or revisions. The DDAS automatic checkout encountered numerous malfunctions and problems. Several revisions were made to the procedure, and eleven FARR's were written to reject and replace the remote analog submultiplexer, P/N 1B54062-503; a dc amplifier, P/N 1A82395-1; two channel calibration command decoders, P/N 1A74053-503; a 5 volt excitation module, P/N 1A77310-505; two pressure transducers, P/N's 1B43320-601 and 1B43324-601; three transducer kits, P/N's 1B40242-501 and -555; and three Rocketdyne transducers, P/N's NA5-27412T7LT, NA5-27412T10T, and NA5-27412T15T. As replacements for the Rocketdyne transducers were not immediately available, the DDAS checkout was held open until after the all systems test was finished, and was then satisfactorily completed.

The power distribution system automatic checkout was accomplished with no particular problems, although several procedure revisions were required. Most of the hydraulic system fill, flush, bleed, and fluid samples procedure was accomplished after two FARR's rejected and replaced two hose assemblies.

2.2 (Continued)

After the pitch hydraulic actuator was replaced during the hydraulic systems test, as noted below, those parts of the test involving the pitch actuator were repeated, with one additional FARR written to correct a problem with the replacement actuator. Several revisions were also made to the procedure. The procedure was satisfactorily completed with the preshipment preparations after the all systems test was finished.

The propellant utilization system calibration and automatic checkout, the exploding bridgewire system and auxiliary propulsion system automatic checkouts, and the range safety receiver and system automatic checkouts, were all completed with only minor problems, although several procedure revisions were made as necessary. The static inverter-converter, P/N 1A66212-507, was rejected and replaced by one FARR during the propellant utilization system calibration.

The hydraulic system automatic checkout was satisfactorily completed after one FARR rejected and replaced the pitch hydraulic actuator, P/N 1A66248-507-012. Minor procedure revisions were also made to correct errors. The replacement of the hydraulic actuator required a repeat of parts of the hydraulic fill, flush, bleed, and fluid sample procedure, and a second issue of the engine alignment procedure, as previously noted. The propulsion system automatic checkout was completed with only minor problems, although several procedure revisions were made. No FARR's were written during this test.

Except for the open DDAS procedure, the individual systems tests were completed by the end of August, and the all systems test was initiated on 5 September 1967. No major problems were encountered during the test, although several procedure revisions were made and two FARR's were written after a review of the test data. One FARR rejected and replaced a channel decoder assembly, P/N 1A74053-503, while the second FARR noted excessive noise levels on twelve measurements. After the completion of the all systems test and the DDAS procedure, the final thermoconditioning system post-checkout procedure was accomplished on 14 and 15 September 1967, with no problems.

2.3 Post-Checkout Propellant Tanks Leak Check

Following the VCL final acceptance checkout, the stage was moved to tower 8 for a production acceptance leak test of the propellant tanks assembly. This was accomplished between 25 and 27 September 1967.

The leak check was performed by pressurizing the tanks with gaseous helium, and utilizing a USON leak detector and bubble solution to determine areas of excessive leakage. Of the six leaks discovered, five were reworked by replacing conoseals, while the remaining leak was accepted for use, with corrective action to be taken at STC. The leak check was rerun acceptably to verify the accomplished reworks.

A more detailed narration of this test appears in paragraph 4.3.

2.4 Stage Retention

At the conclusion of the checkout activities, the stage was prepared for storage at Huntington Beach per Work Release Order (WRO) 3631, and was placed in storage on 3 November 1967. Those activities occurring during stage storage, and during the subsequent preparations for stage shipment to STC, are covered in section 5.

SECTION 3

STAGE CONFIGURATION

3.0 STAGE CONFIGURATION

The paragraphs of this section define the configuration of this stage, and note the applicable variations. Paragraph 3.1 discusses the means used to verify the stage configuration, and paragraph 3.2 contains those variations in stage configuration which represent changes in the scope of the program. Existing contractual configuration control papers are referenced wherever possible.

A listing of all time/cycle significant items on the stage, along with the accumulated time/cycles for each item, is presented in paragraph 3.3.

3.1 Design Intent Verification

The configuration of this stage is defined in the Engineering Configuration List (ECL), Space Vehicle, Model DSV-4B-2-1, Manufacturing Serial Number 2012, dated 12 June 1967. This ECL document includes a listing of all parts, non-hardware drawings, and manufacturing and process specifications required for the manufacture and test of the stage, as defined by Engineering production drawings and Engineering Order (EO) releases. The ECL has been transmitted to NASA under a separate cover.

Verification of design intent was accomplished by a comparison of the ECL, the Planning Configuration List (PCL), and the Reliability Assurance Department As-Built Configuration List (ABCL). Any discrepancies found were resolved by the contractor, and a listing of the resultant action is filed at the contractor's facility.

3.2 Scope Change (SC) and Engineering Change Proposal (ECP) Verification

Scope Changes and Engineering Change Proposals, with applicable verification data, are listed in Form DD829-1, which is included in the Stage Log Book. The following paragraphs list those SC/ECP's which were incorporated and verified prior to retention of the stage at SSC. Paragraph 3.2.1 contains the numbers of those SC/ECP's which were incorporated in the initial design of the stage. Paragraph 3.2.2 lists and briefly describes those SC/ECP's which were incorporated and verified subsequent to the release of initial stage drawings, but prior to retention at SSC. Those SC/ECP's which are verified at STC, and those which will be incorporated and verified subsequent to stage turnover to NASA, will be described in the STC NEIR. Those SC/ECP's which are verified after stage retention and prior to shipment to STC appear in section five.

3.2.1 Scope Changes/Engineering Change Proposals Incorporated in the Initial Design

SC 1016B	SC 1266
SC 1027B	SC 1278A
SC 1075B	SC 1280
SC 1096	SC 1282
SC 1104A	SC 1295
SC 1115	SC 1306
SC 1151	SC 1354
SC 1152	SC 1363
SC 1167	SC 1364
SC 1176	SC 1390
SC 1185	SC 1397
SC 1195A	ECP X005
SC 1196	ECP X043
SC 1230	ECP X095
SC 1232A	ECP X147

3.2.2 Scope Changes/Engineering Change Proposals Incorporated and Verified Prior to Transfer

The following SC/ECP's were incorporated during manufacture and were substantiated as being incorporated by Douglas and AFQA personnel "buy off" of the AO paper. The SC/ECP's are listed as previously complied with (PCW) on form DD829-1.

a. SC 1045B, authorized by CCO 118, provided design specifications for the forward skirt thermoconditioning system.

b. SC 1124, authorized by CCO 259, provided closed loop checkout ability for the stage range safety command RF system.

c. SC 1153A, authorized by CCO's 163 and 280, provided for the redesign of propellant dispersion system, to enable rapid installation of system components under prelaunch conditions at KSC.

d. SC 1187, authorized by CCO's 136, 172, and 330, installed the MSFC furnished control accelerometers and rate gyro.

e. SC 1189, authorized by CCO's 111 and 126, provided for the design, release, and manufacture of the necessary parts and documents for the two-hour and four-and-one-half hour translunar coasts.

f. SC 1193, authorized by CCO 156, provided for the redesign of the LOX tank vent line and supporting hardware.

g. SC 1203, authorized by CCO 168, provided for rpm measurements of the LOX and LH_2 turbopumps.

h. SC 1205, authorized by CCO 173, provided for the installation of three additional interface connectors.

i. SC 1207, authorized by CCO's 197, 213, 330, 343, and 414, provided for the modification of the propellant utilization system.

3.2.2 (Continued)

j. SC 1218, authorized by CCO's 202 and 330, provided for a recirculation type chilldown system.

k. SC 1219, authorized by CCO 201, provided for the removal of telemetry circuits monitoring the APS.

l. SC 1241, authorized by CCO 222, provided an additional sensing element for the engine cutoff circuit.

m. SC 1274, authorized by CCO's 264 and 330, provided short circuit protection for the power supplies.

n. SC 1297A, authorized by CCO's 284 and 330, provided that the forward skirt venting system be modified.

o. SC 1304, authorized by CCO 288, provided for the reduction of LH_2 tank pressure, with associated design changes.

p. SC 1326, authorized by CCO's 279 and 595, provided stage and GSE pressure measurements for the recirculation chilldown pumps.

q. SC 1376A, authorized by CCO's 395 and 467, provided for the reduction of trapped propellants at burnout.

r. ECP X021, authorized by CCO 363, provided for static test monitoring of the engine turbopump rpm.

s. ECP X056, authorized by CCO's 413 and 572, provided that consecutive reference designation numbers be assigned to stage relays.

t. ECP X082, authorized by CCO's 434 and 539, provided new engine transducer design requirements.

u. ECP X085, authorized by CCO 444, provided for the redesign of the engine cutoff circuitry.

v. ECP X099, authorized by CCO 461, provided for additional hardwire measurements through the umbilical.

w. ECP X113, authorized by CCO's 472 and 539, provided a method for implementing the secure range safety command system.

x. ECP X114, authorized by CCO 482, provided for independent excitation of power supplies.

y. ECP X124, authorized by CCO's 506, 539, and 562, provided for changes in the stage for Rocketdyne ECP compatibility.

z. ECP X126, authorized by CCO's 511, 551, 578, and 607, provided for changes in the cryogenic repressurization system.

aa. ECP X132, authorized by CCO's 383, 422, and 435, provided for redesign of the operational telemetry system.

ab. ECP X134, authorized by CCO's 526, 573, and 636, provided for the redesign of the J-2 engine electrical interface.

ac. ECP X136, authorized by CCO's 329, 538, and 631, provided for the release of a coolant system common to both the S-IB and S-V stages.

3.2.2 (Continued)

ad. ECP X137, authorized by MSFC letter I-V-S-TD-65-53, defined the programmed mixture ratio.

ae. ECP X154, authorized by CCO's 543, 612, and 790, provided for the design and procurement of control relay packages.

af. ECP X176, authorized by CCO 587, modified the thrust structure.

ag. ECP X178, authorized by CCO 597, provided for the release of a stage positive pressure system.

ah. ECP X180, authorized by NASA letters TD 65-48, L740, and L972, specified certain changes to mission control measurements.

ai. ECP X190, authorized by NASA letter I-CO-S-IVB-5-762, provided for rework and redesign of the forward skirt environmental control system.

aj. ECP X198, authorized by CCO's 658 and 692, revised the engine thrust OK circuits.

ak. ECP X209, authorized by CCO 847 and NASA letter L96, revised forward skirt paint requirements.

al. ECP X224, authorized by CCO 739, provided for rpm measurements for the recirculation chilldown pump.

am. ECP X262, authorized by CCO's 813 and 853, modified the emergency detection system cutoff circuits.

an. ECP 0271, authorized by letter I-CO-S-IVB-6-442, provided for additional measurements of the range safety system.

ao. ECP 0281, authorized by letter I-CO-SD-L-380-66, provided for a common design effort for the stage coolant system.

ap. ECP 0318, authorized by letter I-CO-S-IVB-6-519, modified the range safety controller safing plug.

aq. ECP 0354, authorized by "make work", provided for a thermal barrier for the ambient helium fill module.

ar. ECP 0444, authorized by "make work", provided for wire installations in branched wire harness 403W4.

as. ECP 0449, authorized by "make work", modified the forward skirt thermoconditioning panels.

at. ECP 0471, authorized by "make work", provided for the installation of a common dome pressure transducer.

au. ECP 0479, authorized by "make work", provided for wiring changes in the PAM inputs to the DDAU.

av. ECP 0488, authorized by "make work", provided for the installation of an ullage pressure transducer in the forward dome.

aw. ECP 0505-R1, authorized by "make work", modified the breakpoint amplifier modules.

ax. ECP 0510, authorized by "make work", provided for the installation of coaxial cable assembly 411W212.

3.2.2 (Continued)

ay. ECP 0519, authorized by "make work", provided for rework of the impingement curtain supports.

az. ECP 0533, authorized by "make work", provided for the installation of temperature and pressure transducers in the hydraulic accumulator/reservoir.

ba. ECP 0613-R1, authorized by NASA letter I-CO-S-IVB-6-1176, provided for replacement of the hydraulic hose support bracket bolts.

bb. ECP 0680, authorized by NASA letter I-CO-S-IVB-6-1380, provided for inverter-converter 21 vdc measurements.

bc. ECP 02309, authorized by CCO 1383, provided for the reconfiguration of the LH_2 chill system supply duct.

bd. ECP 2079-R2, authorized by CCO's 1231 and 1318, modified the rain baffles for the environmental system vents.

be. ECP 2164, authorized by "make work", provided for the replacement of the EBW wiring supports.

3.3 Time/Cycle Significant Items

Thirty items on the stage are time/cycle significant as defined by design requirements drawings 1B55423, Government Furnished Property Time/Cycle Significant Items, and 1B55425, Reliability Time/Cycle Significant Items. The following table lists these items, the time/cycle accrued on each item at the time of stage storage at SSC, and the maximum allowable limits prescribed by Engineering.

Part Number and Part Name	Serial Number	Accumulated Measurement	Engineering Limit
Reliability Items (1B55425 P)			
1A48858-1 Helium Storage Sphere	1138	3 cycles	50 cycles
	1145	3 cycles	50 cycles
	1165	6 cycles	50 cycles
	1170	2 cycles	50 cycles
	1174	2 cycles	50 cycles
	1177	2 cycles	50 cycles
1A49423-507 LH_2 Chilldown Pump	160	(Data Not Available)	100 hours
1A49423-507 LOX Chilldown Pump	1863	119.30 minutes	1,200 minutes
1A59562-505	Not Installed		5,000 cycles
PU Bridge Potentiometer	Not Installed		5,000 cycles

3.3 (Continued)

Part Number and Part Name	Serial Number	Accumulated Measurement	Engineering Limit
1A66241-509 Auxiliary Hydraulic Pump	X454664	32.2 hours	120 hours
		78 cycles	300 cycles
1B57731-1 Control Relay Package	340	249 cycles	100,000 cycles
	354	100 cycles	100,000 cycles
G.F.P. Items (1B55423 G)			
40M39515-113 EBW Firing Unit	268	21 firings	1,000 firings
	273	22 firings	1,000 firings
40M39515-119 EBW Firing Unit	532	28 firings	1,000 firings
	533	25 firings	1,000 firings
	534	26 firings	1,000 firings
	535	28 firings	1,000 firings
	536	19 firings	1,000 firings
	537	25 firings	1,000 firings
	538	18 firings	1,000 firings
	539	36 firings	1,000 firings
50M10697 Command Receiver	107	30.3 hours	2,000 hours
	108	31.0 hours	2,000 hours
50M10698 Range Safety Decoder	21	125.6 hours	2,000 hours
	102	29.7 hours	2,000 hours
50M67864-5 Switch Selector	163	8195 cycles	250,000 cycles
103826 J-2 Engine (for gimbal cycles)*	J-2103		
a. Customer connect lines and inlet ducts		5.0%	250-10,000 cycles
b. Gimbal bearings		5.3%	250-10,000 cycles
c. Firing time		615.4 sec	3,750 seconds
d. Helium Regulator (P/N 558100)	4088154	(Data Not Available)	Not Established

*This data includes all engine gimbal cycles at SSC, plus cycles brought forward from Rocketdyne records. The cycle data is expressed as a percent of design limits based on the gimbal angle, and can vary from 250 to 10,000 + cycles as noted. The indicated percentages were computed from the Engine Log Records utilizing the graph per Rocketdyne Rocket Engine Data Manual R-3825-1.

SECTION 4

NARRATIVE

4.0 NARRATIVE

A detailed narration of the stage checkout is presented in this section in the chronological order of testing. The major paragraphs comprising the detailed narrative are: 4.1 Stage Manufacturing Tests; 4.2 Stage Checkout - SSC/VCL; and 4.3 Propellant Tanks System Leak Test. These major paragraphs are subdivided to the degree required to present a complete historical record of stage checkout.

Permanent nonconformances and functional failures affecting the stage have been recorded on FARR's, and are referred to by serial number throughout this section (e.g. FARR A261305). The referenced FARR's are presented in numerical order in Table I and Table II of Appendix II.

4.1 Stage Manufacturing Tests

During the manufacturing sequence of the stage, two major manufacturing tests were conducted to verify the structural integrity of the stage propellant tank assembly. These two tests, the hydrostatic proof test and the propellant tanks leak check, are presented in this paragraph. FARR's referenced in this paragraph are presented in Table I of Appendix II.

4.1.1 Hydrostatic Proof Test (1B38414 G)

The hydrostatic proof test was conducted on the tank assembly for the stage to ensure the structural integrity of the LOX and LH_2 tanks and to verify that the tank assembly could withstand the required test pressures without leakage or damage. The item subjected to this test was the tank assembly, P/N 1A39303-537, S/N 2012, without the thrust structure installation, P/N 1A39312, the LOX sump installation, P/N 1A39154, or the LH_2 door installation, P/N 1B64441.

The hydrostatic proof test was accomplished on 8 and 9 March 1967, using acceptance test procedure (ATP) A659-1B38414-1-PATP16. The test involved varying the water head pressure inside the LOX and LH_2 tanks, while varying the water in the test tank to equalize the hydrostatic head pressure across the skin of the tank assembly, as required to accomplish the following:

a. Proof the common bulkhead to a positive (internal) pressure differential of 27.5 +0.5, -0.0 psi, and the LOX tank at the common bulkhead joint to 28.7 +0.5, -0.0 psi.

4.1.1 (Continued)

b. Proof the common bulkhead to a negative (external) pressure differential of -20.6 +0.0, -0.5 psi, and the LH_2 tank at the common bulkhead joint to 22.5 +0.5, -0.0 psi.

c. Proof the aft LOX tank to a positive (internal) pressure differential of 51.0 +0.5, -0.0 psi, and the common bulkhead at the common bulkhead to aft dome joint to 19.2 +0.5, -0.0 psi.

d. Proof the LH_2 tank aft dome to 38.0 +0.5, -0.0 psi, and the common bulkhead at the common bulkhead to aft dome joint to a positive (internal) pressure differential of 5.2 +0.0, -0.5 psi.

The water head pressures were varied by adjusting the water levels in the hydrostatic test tower outer tank, LOX tank standpipe, and LH_2 tank standpipe. There was no direct correlation between the standpipe water levels used during the test and the specified pressure requirements, but the levels used were those established by Engineering to provide the required pressures.

The following water levels were achieved during the appropriate steps of the procedure. For the LOX tank pressure check the outer tank was empty, the LOX standpipe level was 81.0 feet, and the LH_2 standpipe level was 36.7 feet. For the common bulkhead positive pressure check the outer tank was full to the top of the LH_2 tank, the LOX standpipe level was 66.2 feet, and the LH_2 standpipe level was 2.8 feet. For the common bulkhead negative-pressure check the outer tank was full, the LOX standpipe level was 3.9 feet, and the LH_2 standpipe level was 51.7 feet. For the LH_2 tank pressure check the outer tank was full, the LOX standpipe level was 99.6 feet, and the LH_2 standpipe level was 87.6 feet.

For each check, the levels were maintained for five minutes, to verify that there was no leakage or damage in the tank assembly. Following the test, the tank assembly and test tower were drained, and the tank assembly was rinsed and dried in preparation for further manufacturing operations.

No major discrepancies or problems were encountered during this test, and no FARR's were written. Some minor leakage at the LH_2 fill elbow was

4.1.1 (Continued)

satisfactorily corrected during the test. Eight revisions were made to the procedure for the following:

a. Three revisions corrected an indicator designation to be F-20 rather than F-1 at five places in the procedure.

b. One revision added instructions to drain the LH_2 tank to permit repair of a leak in the LH_2 fill elbow, and then to refill the tank per the test conductors instructions.

c. One revision deleted one step that set the Domestic Function Selector during the outer tank fill operation.

d. One revision reversed the sequence of two steps during the outer tank fill operation.

e. One revision corrected a step during the common bulkhead negative pressure operation to close the LH_2 standpipe valve at the 8.1 foot level as well as the valve at the 2.8 foot level.

f. One revision corrected a step during the LH_2 tank pressurization operation to verify that panel light F-6 indicated TEST or HIGH, rather than only TEST.

4.1.2 Propellant Tanks Leak Check (1B38414 G)

The propellant tanks leak check verified the integrity of the stage tank assembly, and ensured that no leaks existed in the tank assembly welds, or in areas where the tank wall was penetrated by lockbolts or other fasteners attaching structural items to the tank assembly. The item tested by this procedure was tank assembly, P/N 1A39303-537, S/N 2012.

The leak check was initiated on 14 March 1967, using test procedure A659-1B38414-1-PATP30, and was completed on 17 March 1967, after 4 days of activity. There were no part shortages at the start of the test, and no parts were changed as a result of the test.

The first part of the test was a preliminary leak check of the production test equipment (PTE). The LOX tank was pressurized to 3.2 psig with gaseous nitrogen, and bubble solution was used to check the LOX tank PTE adapters and connectors for leakage. Upon completion of the LOX tank check, the LH_2 tank was pressurized to 3.0 psig with gaseous nitrogen, and the LH_2 tank PTE adapters and connections were similarly checked with bubble solution.

4.1.2 (Continued)

A tank assembly integrity test was then started by pressurizing both the LOX tank and the LH_2 tank to 12.0 psig with gaseous nitrogen. The nitrogen supply valves were then closed and the tank pressures were noted. After 10 minutes, the tank pressures were measured as 11.9 psig for both the LOX tank and the LH_2 tank, indicating that there was no major tank leakage. The tanks were then vented to atmosphere until the pressures in the LOX and LH_2 tanks reached 8.3 psig each.

The last phase of the test was a freon injection test. The freon gas was flowed into the tanks at 20 cubic feet per minute until the tank pressures reached 10.0 psig for the LH_2 tank and 10.1 psig for the LOX tank. The freon system downstream of the evaporator, and from the evaporator to the freon bottles, was then bled to atmosphere. After allowing 1 hour for freon gas diffusion, bubble solution and a halogen detector were used to leak check the tanks at all weld areas and at all lockbolts or other structural fasteners that penetrated the tank wall. At the conclusion of the freon leak check, the tanks were exhausted to atmosphere, then purged with dry air and recapped to ensure cleanliness.

No discrepancies were noted during the operation of this procedure, and no FARR's were written. Four revisions were made to the procedure to change the test mode switch S-2 position designations from "Leak Test and Vent" to "Warning Lights Off" at three places in the procedure, and from "Fill and Integrity" to "Warning Lights On" at one place in the procedure.

4.2 Stage Checkout - SSC/VCL

This paragraph details the tests performed on the stage in the Vehicle Checkout Laboratory (VCL) at the MDAC Space Systems Center, Prior to transfer of the stage for shipment to the Sacramento Test Center. The stage was placed in tower 6 of the VCL on 29 June 1967. System checkouts were initiated on 25 July 1967, and continued until 14 September 1967. Checkout activity was active for 37 working days during this period. All tests required by the End Item Test Plan, 1B66532-511F, dated 5 April 1967, were activated and completed.

4.2 (Continued)

Six interim use parts were installed at the time of the all systems simulated flight test. These were three engine temperature transducers, and three engine pressure transducers. The three pressure transducers were replaced before VCL testing was terminated while the three temperature transducers will be replaced prior to stage static firing at STC.

Paragraphs 4.2.1 through 4.2.33 contain information on the individual tests conducted, and are presented in the sequential order of testing.

4.2.1 Continuity Compatibility Check (1B59763 G)

Prior to mating the stage to the VCL electrical support equipment, an end-to-end continuity check was made of all electrical cables and wire harnesses installed on the stage, to ensure the integrity of the stage electrical systems, and to verify that the stage was prepared for the application of electrical power for VCL testing. Where possible, the end-to-end continuity of wire runs was measured through electrical component boxes. The test involved all wire harnesses and electrical wiring installed on the stage.

Initiated on 25 July 1967, the procedure was completed by 11 August 1967, after a total of 8 days of activity. The procedure was certified and accepted on 14 August 1967. Stage wiring continuity was verified by a total of 1963 individual point-to-point resistance measurements, specified in the test procedure by reference item numbers, "from" component, cable, plug, and pin designations, and "to" component, cable, plug, and pin designations. There were 1854 of the measurements within the original resistance requirement of 1.0 ohm or less. For an additional 70 measurements, indications between 1.0 and 3.0 ohms were acceptable because of the length and type of wire involved. Another 39 measurements were accepted with indications of 50 ± 5 ohms, as these measurements were made through modules containing 49.9 ohm resistors.

Engineering comments noted that transducer assembly 403MT670, P/N 1B40242-517, for measurement D2, was not installed at the start of the test, but was installed and tested before the test was completed. Two problems were encountered during the test, as noted on IIS 366173. One problem was a lack

4.2.1 (Continued)

of continuity between pins 404W34J1-M and 404W34J2-M; the other was a recessed pin, 404W34P3-M, on wire harness, P/N 1A83895-1, at location 404A70A1. Both problems were corrected by reinserting the pins properly, and no FARR action was required.

Two revisions were made to the procedure, to note the 70 measurements that were acceptable at 1.0 to 3.0 ohms because of the wire types and lengths involved, and to note the 39 measurements that were acceptable at 50 ±5 ohms because they were made through modules containing 49.9 ohm resistors.

4.2.2 Forward Skirt Thermoconditioning System Checkout Procedure (1B41926 B)

Before automatic checkout activities were started on the stage, the forward skirt thermoconditioning system was functionally checked by this procedure to prepare it for operation and to verify that the system was capable of supporting stage checkout operations. The items involved in this test were the forward skirt thermoconditioning system, P/N 1B38426-529, and the GSE Model DSV-4B-359 thermoconditioning servicer, P/N 1A78829-1.

The checkout of the forward skirt thermoconditioning system was started on 25 July 1967, and was completed on 27 July 1967, after 3 days of activity. The procedure was certified as acceptable on 27 July 1967.

After the preliminary setup of the Model 359 GSE servicer and an inspection of the forward skirt thermoconditioning system for open bolt holes and properly torqued bolts, the thermoconditioning system was purged with freon gas, and then pressurized to 32 ±1 psig with freon. A system leak check was conducted using a gaseous leak detector, P/N 1B37134-1, set to a sensitivity of 1 on the OZ/YEAR-R12 scale. No leakage was found at any of the system B-nuts and fittings, manifold weld areas, panel inlet and outlet boss welds, or manifold flexible bellows.

The thermoconditioning system was purged with GN_2, then water/methanol coolant was circulated through the system. Coolant samples were taken from both the fluid sample pressure valve (system inlet), and the fluid sample

4.2.2 (Continued)

return valve (system outlet), and checked for cleanliness, specific gravity, and temperature. The cleanliness analysis showed that no contaminant particles were present in the coolant. The specific gravity was 0.897 at a temperature of 60°F.

A differential pressure test was conducted by measuring the pressure difference between the thermoconditioning system inlet and outlet while a coolant flow rate of 7.8 ±0.1 gpm was maintained. The coolant temperature was also measured at the system inlet and outlet. Ten measurements, taken at 2 minute intervals, showed that the differential pressure varied from 14.55 psid to 14.8 psid. The supply (inlet) temperature varied from 58°F to 62°F, and the return (outlet) temperature varied from 60°F to 62°F.

Finally, an air content test was performed by stabilizing the thermoconditioning system coolant static pressure at 20 ±0.5 psig, and draining sufficient fluid from the system to reduce the static pressure by 15 ±0.5 psig. The quantity of fluid drained was measured as 40 cc, acceptably less than the 48 cc maximum permissible quantity for the five cold plate configuration of the thermoconditioning system.

Engineering comments indicated that all parts were installed at the start of the test. No discrepancies or problems were noted during the test, and no FARR's were written. The one revision against the procedure set the GSE servicer ON LOCAL/OFF/ON REMOTE switch to the OFF position instead of to the ON LOCAL position at one point, to correct a typing error.

4.2.3 Forward Skirt Thermoconditioning System Operating Procedure (1B42124 A)

This manual procedure controlled the setup and normal daily operation of the GSE Model DSV-4B-359 thermoconditioning servicer, P/N 1A78829-1, used to supply water/methanol coolant to the forward skirt thermoconditioning system, P/N 1B38426-529. The water/methanol coolant provided the heat source or sink, as necessary, for proper operation of the forward skirt mounted electronic components during VCL checkout.

4.2.3 (Continued)

Initiated on 27 July 1967, the procedure was completed on 14 September 1967, and was accepted on 22 September 1967. The forward skirt thermoconditioning system was operated 36 times during 33 days of activity in this period, for a total of 412.6 hours. The GSE servicer was set up for operation, and the coolant supply and return hoses, P/N's 1B37641-1 and -501, were verified to be connected between the servicer and the stage thermoconditioning system. The servicer fluid level was verified to be within the proper limits. The panels of the forward skirt thermoconditioning system were inspected to verify that there were no open equipment mounting bolt holes. The servicer was purged with gaseous nitrogen, and the servicer power was applied.

For normal operation during VCL testing, the servicer was continuously purged with gaseous nitrogen to prevent any possible ignition of the methanol vapors within the servicer. When required for use, the servicer was turned on, the fluid temperature control was adjusted to stabilize the supply temperature gauge reading between 80°F and 90°F, and the servicer flowmeter indication was verified to be 7.8 ±0.3 gpm. The water lines, the servicer internal piping, the pressure and return hoses to the stage, and the stage system were visually checked for leakage. At 30 minute intervals during automatic checkout operations, a check was made to verify that the supply temperature, the coolant flowrate, the coolant supply and return pressures, the gaseous nitrogen source pressure, and the servicer fluid level were within the proper limits, and that there was no leakage. At the end of each use, the servicer was shut down, and it was verified that the servicer filter differential pressure indicator buttons were down, and that the coolant pump was stopped with a flowrate of approximately zero gpm. At the conclusion of VCL testing, the servicer and thermoconditioning system were secured by the Forward Skirt Thermoconditioning System Post-Checkout Procedure, H&CO 1B62965, (reference paragraph 4.2.33).

Engineering comments noted that there were no parts shortages affecting this test. No problems were encountered during this procedure, and no FARR's were written. No revisions were made to the procedure.

4.2.4 Engine Alignment Procedure (1B39095 A)

The engine alignment procedure was conducted to verify that the exit plane of the J-2 engine thrust chamber was properly aligned with respect to the S-IVB stage structure. The items involved in this test were the J-2 engine, P/N 103826, S/N J2103; the hydraulic pitch actuator, P/N 1A66248-507-012, S/N 65; the hydraulic yaw actuator, P/N 1A66248-507-012, S/N 64; and the stage, P/N 1A74633-521, S/N 2012.

The engine alignment verification was initially accomplished and accepted on 27 July 1967. Subsequent to this, the hydraulic pitch actuator, P/N 1A66248-507-012, S/N 66, was rejected for oil leakage during the hydraulic system automatic procedure, H&CO 1B59485. (Reference FARR A261324, paragraph 4.2.28). A new actuator, S/N 65, was installed, and a second issue of the engine alignment verification was accomplished on 28 August 1967, and accepted on 29 August 1967. The following narration covers both issues of this procedure.

A Wild N-3 alignment scope was first used to determine the difference in elevation of datum plane "G" at four locations around the stage periphery. Datum plane "G" was defined as the mating surface between the aft skirt and the handling ring. The elevations at the four locations were determined to be 2.000 inches, 2.010 inches, 1.990 inches, and 1.982 inches. The maximum deviation between any two locations was 0.028 inch, well within the 0.062 inch maximum deviation limit.

The hydraulic actuator engine log book lengths, adjusted lengths, and final lengths, were obtained from the actuator data tags and recorded. For the pitch actuator, S/N 65, these lengths were respectively 22.966 inches, 22.936 inches, and 22.935 inches. For the yaw actuator, S/N 64, these lengths were respectively 23.004 inches, 22.974 inches, and 22.972 inches.

The engine exit plane alignment fixture, P/N 1B54581-1, was positioned and attached to the J-2 engine exit flange, and two clinometers, P/N 1B29613-1, were positioned on the machined surface block of the fixture. From the clinometer readings, the pitch plane adjusted angle was found to be 7.4 minutes

4.2.4 (Continued)

low toward stage position I, and the yaw plane adjusted angle was found to be 1.9 minutes low toward stage position IV. From these measurements, the adjusted exit plane inclination angle was determined to be 7.6 minutes, with the low quadrant between stage positions I and IV. This exit plane inclination was well within the maximum inclination limit of 21 minutes.

Engineering comments indicated that all parts were installed at the start of the test. No discrepancies were noted during the test, and no FARR's were written. Two revisions were made to the first issue of the procedure, and three revisions were made to the second issue, for the following:

a. Two revisions, applicable to both issues, deleted all of the test steps that measured and adjusted the hydraulic actuator lengths, as these adjustments were made per 1B66209 prior to installation of the actuators; and transferred the pitch and yaw actuator serial numbers and length data from the tags provided by 1B66209 into the procedure table, to keep a permanent record of the actuator measurements.

b. One revision, applicable only to the second issue, picked up the datum plane "G" information and the yaw actuator length information from the first issue, as replacement of the pitch actuator did not affect either the datum plane or the yaw actuator, and these parts of the procedure were not repeated.

4.2.5 Cryogenic Temperature Sensor Verification (1B64678 B)

This manual procedure verified the operation and calibration of each cryogenic temperature sensor on the stage whose normal operating range did not include ambient (room) temperature. These cryogenic temperature sensors are basically platinum resistance elements whose resistance changes with temperature according to the Callendar-Van Dusen equation.

The procedure was accomplished on 27 July 1967, and was accepted on 28 July 1967.

For each sensor tested, the procedure specified a resistance value at 32°F and a sensitivity value. Using these values and the measured ambient temperature, the expected ambient temperature resistance was calculated for each sensor. The applicable resistance tolerances were also calculated. These tolerances were 5 percent of the expected resistance, except for four specified

4.2.5 (Continued)

sensor types which were allowed a 7 percent tolerance. The actual ambient resistance of each sensor was then measured and verified to be within the applicable tolerance of the expected resistance. The sensor wiring was verified to be correct by shorting out the sensor element, measuring the continuity resistance, and verifying that this was 5.0 ohms or less. Test Data Table 4.2.5.1 shows the measured and calculated values for each sensor involved in this test.

Engineering comments indicated that there were no parts shortages affecting this test. No problems were encountered during the test, and no FARR's were written. Four revisions were made to the procedure:

a. One revision deleted adaptor cable, P/N 1B40895-1, from the Non-End Item Requirements list, as it was not required for the test.

b. One revision corrected a temperature sensor call-out from 1B6783-519 to be 1A67863-519.

c. One revision added a final step to the procedure, to reconnect the temperature sensors to the vehicle configuration at the end of the test, to correct a procedure omission.

d. One revision changed the procedure Test Record Table to show that the effectivity of measurement CO 004-403, as listed, was SV stages only, rather than SI and SV stages; and added a new entry to the table for measurement CO 004-403 with SI effectivity. A separate entry was required for each stage type because of differences in the wire harness, bridge module, and advance functional schematic sequence designation numbers associated with the measurement.

4.2.5.1 Test Data Table, Cryogenic Temperature Sensor Verification

Meas	Sensor			Temp	Resistance (ohms)			
Number	P/N	S/N	Ref Desig	(°F)	Meas	Calc	± Tol	Cont
CO 003	1B34473-1	335	403MT686	83	5200.	5561.	389.2	0.1
CO 004	1B34473-501	338	403MT687	83	1577.	1557.	77.85	1.1
CO 005	1A67863-503	931	405MT612	83	560.	556.1	27.8	0.5
CO 008	1A67863-507	1240	403MT652	83	1550.	1555.	77.54	0.1
CO 009	1A67863-535	720	403MT653	83	223.	222.44	11.12	1.1
CO 015	1A67863-509	1079	410MT603	86	1570.	1566.	78.30	1.2
CO 040	1A67862-505	432	406MT613	83	1530.	1535.	76.75	1.0
CO 052	1A67862-513	568	408MT612	86	5360.	5394.	280.	1.7
CO 133	NA5-27215T5	--	401(3MTT17)	83	1413.	1396.	69.80	0.7

4.2.5.1 (Continued)

Meas Number	Sensor P/N	Sensor S/N	Sensor Ref Desig	Temp (°F)	Resistance (ohms) Meas	Resistance (ohms) Calc	Resistance (ohms) ± Tol	Resistance (ohms) Cont
CO 134	NA5-27215T5	--	401(3MTT16)	83	1420.	1396.	69.80	0.7
CO 157	1A67863-537	1205	404MT685	83	5340.	5561.	389.	0.9
CO 159	1A67863-519	1223	424MT610	83	227.	222.40	11.1	1.1
CO 161	1A67863-537	1198	404MT733	83	5380.	5561.	389.	0.9
CO 163	1A67863-519	1224	424MT613	83	223.	222.44	11.12	0.2
CO 207	1A67863-503	860	425MT600	86	569.	559.	27.95	1.4
CO 208	1A67863-503	1179	405MT605	83	560.	556.1	27.8	1.3
CO 254	1B37878-503	510	409MT652	86	1600.	1566.	78.30	0.9
CO 255	1B37878-503	1301	409MT653	86	1638.	1566.	78.30	0.7

4.2.6 Aft Skirt and Interstage Thermoconditioning and Purge System (1B40544 B)

The checkout of the aft skirt and interstage thermoconditioning and purge system was accomplished by this test procedure to verify that the airflow characteristics of the system were correct, and to show that the system could provide the inert environment required in the aft skirt and interstage area during all prelaunch and test firing operations involving the use of LH_2. The items involved in this test were the aft skirt and interstage thermoconditioning and purge system installation, P/N 1A67979-513, and the GSE Model DSV-4B-651 aft skirt ventilation system kit, P/N 1B38121-1.

This checkout procedure was initiated and completed on 28 July 1967. The procedure was certified as acceptable on the same date. Pre-operation setup steps were accomplished to prepare the Model 651 ventilation system for use, to connect it to the stage, and to cover and seal open holes in the stage system airflow areas. The stage system tests were conducted by installing various size orifices in the metering duct of the Model 651 aft skirt ventilation system, opening and closing various purge and ventilation holes on the stage, and measuring the Model 651 metering duct pressure difference and the main manifold pressure, while air was blown through the stage system.

For the main manifold leakage and fairing purge test, a 1.4 inch diameter orifice, P/N 1B38983-503, was installed, and the main manifold orifices in the station 241 frame, the hydraulic system accumulator reservoir shroud ventilation holes, and the thrust structure supply duct were sealed. From the measured metering duct orifice pressure difference of 18.2 inches of water,

4.2.6 (Continued)

and the main manifold pressure of 5.1 inches of water, it was determined that the leakage and fairing purge area was 2.85 square inches.

In the thrust structure flow test, a 2.1 inch diameter orifice, P/N 1B38983-507, was installed, the main manifold orifices in the station 241 frame and the hydraulic system accumulator reservoir shroud ventilation holes were sealed, and the thrust structure supply duct was opened. From the metering duct pressure difference of 19.5 inches of water and the main manifold pressure of 4.3 inches of water, it was determined that the gross thrust structure purge area was 7.2 square inches. Subtracting the previously determined leakage and fairing purge area, the net thrust structure purge area was 4.35 square inches, well within the 4.1 ±1.0 square inches requirement.

For the main manifold orifice flow test, a 5.2 inch diameter orifice, P/N 1B38983-511, was installed, all main manifold orifices were opened, the main manifold orifices in the station 241 frame and the hydraulic system accumulator reservoir shroud ventilation holes were opened, and the thrust structure supply duct was sealed. From the metering duct pressure difference of 5.0 inches of water and the main manifold pressure of 1.5 inches of water, the gross main manifold purge area was found to be 52.75 square inches. Subtracting the leakage and fairing purge area, the net main manifold purge area was 49.90 square inches, well within the 49.0 ±6.0 square inches requirement.

Engineering comments indicated that there were no part shortages affecting the test. No discrepancies were noted during the test, and no FARR's were written. One revision was made to the procedure, to set the blower lockout (key lock) switch on the GSE Model 651 to the REMOTE position at the start of the test, rather than to the ON position. This switch was labeled RUN and REMOTE, and had no ON position.

4.2.7 Telemetry and Range Safety Antenna Systems (1B64679 B)

This test procedure was used to verify the integrity of the telemetry and range safety antenna systems by verifying that the continuities, VSWR's, insertion losses, phasing, and power levels of the system were all within the required limits. In addition, the center frequency and carrier deviation of the

4.2.7 (Continued)

PCM/FM transmitter were determined to be correct, and the operation of the PCM FM/FM transmitter and the FM/FM group power functions were checked. The items involved in this test included:

Part Name	Reference Location	P/N	S/N
PCM RF Assembly	411A64A200	1B52721-521-006	32
Bi-Directional Coupler	411A64A204	1A69214-503	159
Coaxial Switch	411A64A202	1A69213-1	82
Power Divider	411A64A201	1A69215-501	47
Telemetry Antennas	411E200 & E201	1A69206-501	42 & 78
Reflected Power Detector	411MT744	1A74776-501	284
Forward Power Detector	411MT728	1A74776-503	296
Dummy Load	411A64A203	1A84057-1	664
Directional Power Divider	411A97A56	1B38999-1	44
Hybrid Power Divider	411A97A34	1A74778-501	33
Range Safety Antennas	411E56 & E57	1A69207-501	45 & 46

Initiated on 28 July 1967, the checkout was completed and accepted on 10 August 1967, after 4 days of activity.

The tests in this procedure were generally performed by disconnecting various transmission lines in the telemetry and range safety RF systems, and determining insertion losses and VSWR's for various segments of the systems. Measurements of the telemetry system components were made at 258.5 ±0.1 MHz, and the range safety system components were measured at 450.0 ±0.1 MHz. A test cable, P/N 1B50922-1, was calibrated for use in the procedure, with the VSWR measured at both operating frequencies. These VSWR's are shown in Test Data Table 4.2.7.1, along with other measurements made during the test.

The telemetry system insertion losses were measured from the PCM RF assembly transmitter output to each antenna, with the other antenna replaced by a 50 ohm load. The phase difference of the transmission lines from the power divider to the antennas was measured with the antennas replaced by short circuit terminations, and the VSWR's of these lines were measured with the antennas connected. With the coaxial switch energized, the telemetry system closed loop VSWR was measured from the transmitter output to the dummy load. With the coaxial switch de-energized, the telemetry system open loop VSWR was measured from the transmitter output to the antennas.

4.2.7 (Continued)

On the range safety system transmission lines, the center conductor continuity resistances were measured from the input of each receiver to the output of each antenna, and the insulation resistances were measured between the center conductor and the shield at both receiver inputs and both antenna outputs. A series of insertion loss checks then measured the isolation between the two receiver inputs; the insertion loss between each receiver and each antenna, and between each receiver and the directional power divider closed loop checkout connector; and the insertion loss in the closed loop checkout cable between the directional power divider and the forward umbilical. VSWR measurements were then made on the transmission lines from the hybrid power divider outputs to each antenna, and on the complete range safety system from the input of each receiver to the antennas.

The stage power was turned on for the PCM transmitter tests. With a dummy load connected to the PCM RF assembly transmitter output, the PCM transmitter center frequency, carrier deviation, and output power were measured. With the transmitter reconnected to the system, the forward power detector output was measured and verified to be within ± 3 percent of the detector calibration requirement for the transmitter output power. For calibration of the reflected power detector, the forward power detector output was measured, and the equivalent forward power was determined from the detector calibration. The reflected power was measured and verified to be 11 ± 1 percent of the forward power. The output of the reflected power detector was then measured and verified to be within ± 3 percent of the detector calibration requirement for the measured reflected power. The ACS forward power and reflected power measurement functions were verified to be within ± 3.5 percent of the measured power values.

A final check verified that the forward bus 1 current did not increase when either the PCM RF assembly power or the FM/FM group power was turned on, and that the telemetry RF silence command would cut off the RF assembly power.

Engineering comments noted that there were no parts shortages affecting this test. No problems were encountered during the test, and no FARR's were written. Ten revisions were made to the procedure for the following:

a. One revision changed the Applicable Documents paragraph to add the omitted drawing numbers for the stage power setup procedures, H&CO

4.2.7 (Continued)

1B59590-1 for SIB stages and H&CO 1B66560-1 for SV stages; and to add the stage power turnoff procedures, H&CO 1B59591-1 for SIB stages and H&CO 1B66561-1 for SV stages, for possible use by this procedure.

b. One revision changed the Non-End Item Test Equipment list to indicate that coaxial adapter, P/N 6018, was used in this procedure, rather than the listed adapter, P/N 6013.

c. One revision changed the Time/Cycle Significant Items paragraph to indicate that the total number of cycles accumulated by the switch selector would be typed out, rather than printed out, at the end of the next automatic procedure to be conducted.

d. One revision deleted the use of the stimuli conditioner to turn on the PCM RF assembly power, as the switch selector use would not be recorded if the stimuli conditioner were used.

e. One revision changed a step to verify that the "50 ohm Sierra RF load (160-50D)" was installed, rather than that the "50 ohm load" was installed. This was to specify the correct load, as both on RF dummy load and a Sierra RF load were used in the procedure.

f. Two revisions deleted a step that manually turned off the stage power functions if they were turned on manually, and added a final step to perform the stage power turnoff automatic procedure at the completion of this test if no other stage testing was to be performed. As the automatic stage power setup had been performed, the manual turnoff was not applicable, and the automatic turnoff was required.

g. Two revisions added the necessary steps to perform the FM/FM transmitter and group power checks.

h. One revision modified the power detector checks to resolve discrepancies in the ACS measurements of the forward power, measurement N18, and the reflected power, measurement N55. Calibration values of 4.59 millivolts per watt for the forward power detector and 3.25 millivolts per watt for the reflected power detector were used in place of the procedure calibration curves, and the Model DSV-4B-123 DDAS ground station, P/N 1A59941-1, was added to the End Item Equipment list for use in measuring the ACS power functions.

4.2.7.1 Test Data Table, Telemetry and Range Safety Antenna Systems

Function	Measurement	Limits
Test Cable Calibration		
VSWR at 258.5 MHz	14.0	-
VSWR at 450.0 MHz	12.0	-
Telemetry System Tests		
Insertion Loss to Antenna 1 (db)	4.6	6.7 max.
Insertion Loss to Antenna 2 (db)	4.7	6.7 max.
Antenna Line Phase Difference (deg)	6.4	30.0 max.

4.2.7.1 (Continued)

Function	Measurement	Limits
Telemetry System Tests (Cont)		
VSWR to Antenna 1	1.43	1.7 max.
VSWR to Antenna 2	0.94	1.7 max.
System Closed Loop VSWR	1.28	1.5 max.
System Open Loop VSWR	1.05	1.7 max.
Range Safety System Tests		
Transmission Line Continuity Resistance		
Receiver 1 to Antenna 1 (ohms)	0.2	0.5 max.
Receiver 1 to Antenna 2 (ohms)	0.2	0.5 max.
Receiver 2 to Antenna 1 (ohms)	0.2	0.5 max.
Receiver 2 to Antenna 2 (ohms)	0.2	0.5 max.
Transmission Line Insulation Resistance		
Receiver 1 (megohms)	30,000.0	100.0 min.
Receiver 2 (megohms)	30,000.0	100.0 min.
Antenna 1 (megohms)	120.0	100.0 min.
Antenna 2 (megohms)	120.0	100.0 min.
Insertion Loss Checks		
Receiver 1 to Receiver 2 Isolation (db)	30.3	25.0 min.
Receiver 1 to Antenna 1 Loss (db)	4.3	6.0 max.
Receiver 1 to Antenna 2 Loss (db)	4.5	6.0 max.
Receiver 2 to Antenna 1 Loss (db)	5.5	6.0 max.
Receiver 2 to Antenna 2 Loss (db)	5.2	6.0 max.
Receiver 1 to Checkout Connector Loss (db)	25.1	24.0 +1.4, -1.0
Receiver 2 to Checkout Connector Loss (db)	23.6	24.0 +1.4, -1.0
Closed Circuit Checkout Cable Loss (db)	1.3	1.5 max.
VSWR Checks		
Power Divider to Antenna 1 Line VSWR	1.37	1.7 max.
Power Divider to Antenna 2 Line VSWR	1.34	1.7 max.
Receiver 1 System VSWR	1.34	1.7 max.
Receiver 2 System VSWR	1.22	1.7 max.
PCM Transmitter RF Tests		
Center Frequency (MHz)	258.509	258.500 $\pm$0.026
Carrier Deviation (kHz)	38.0	36.0 $\pm$3.0
Output Power (watts)	25.2	15.0 min.
Forward Power Detector Output (millivolts)	114.5	115.668 $\pm$3.470
Forward Power Detector Output (millivolts)	128.0	-
Equivalent Forward Power (watts)	27.8	-
Reflected Power (watts)	3.06	3.058 $\pm$0.278
Reflected Power Detector Output (millivolts)	9.94	9.945 $\pm$0.298

4.2.8 Umbilical Interface Compatibility Check (1B59768 D)

The integrity of the stage umbilical wiring was ensured by this procedure through verification that the proper loads were present on all power buses, and that the control circuit resistances for propulsion valves and safety items were within the prescribed tolerances. The procedure involved the stage umbilical system electrical wiring and components.

This procedure was accomplished on 1 and 4 August 1967, and was accepted on 4 August 1967. A series of resistance checks were made at specified test points on the Model 463 signal distribution unit, P/N 1A59949-1, to verify that all wires and connections were intact and of the proper material and wire gauge, and that all resistance values and loads were within the design requirement limits. The test points, circuit functions, measured resistances, and resistance limits are shown in Test Data Table 4.2.8.1. Test point 463A1A5J43-FF was used as the common test point for all measurements.

Engineering comments indicated that all parts were installed at the start of this procedure. No problems or malfunctions were encountered during the procedure, and no FARR's were written. Two revisions were made to the procedure for the following:

a. One revision added steps to connect vehicle input connectors 404W7P9 and 404W7P10 to the J1 receptacles of the chilldown inverters before measuring test point 463A2A2J35-y, the bus 4D141 regulation measurement circuit, and to disconnect and stow these connectors when the test was completed. This was necessary because these connectors were disconnected and stowed when the stage was received in the VCL area.

b. One revision changed several resistance limits to reflect the nominal resistance values of the new LOX and LH_2 vent valves, P/N 1B66692-1. The fuel tank vent pilot valve open and valve boost close command circuits, test points 463A2A2J29-h and i, were to be 30 - 80 ohms rather than 50 ohms maximum and 500 kilohms minimum reverse polarity, and LOX vent valve open and close command circuits, test points 463A2A2J30-W and -X, were to be 30 - 80 ohms rather than 10 - 60 ohms.

4.2.8.1 Test Data Table, Umbilical Interface Compatibility Check

Test Point	Function	Meas. Ohms	Limit Ohms
Reference Designation 463A2			
A2J29-C	Cmd., Ambient Helium Sphere Dump	33.0	10-60
CB-8-2	Cmd., Engine Ignition Bus Power Off	Inf.	Inf.

4.2.8.1 (Continued)

Test Point	Function	Meas. Ohms	Limit Ohms
Reference Designation 463A2 (Continued)			
CB-9-2	Cmd., Engine Ignition Bus Power On	17.0	5-100
CB-10-2	Cmd., Engine Control Bus Power Off	Inf.	Inf.
CB-11-2	Cmd., Engine Control Bus Power On	16.0	5-100
A2J29-N	Cmd., Engine He. Emergency Vent Control On	59.0	10-60
A2J29-Y	Cmd., Start Tank Vent Pilot Valve Open	25.0	10-60
CB4-2	Cmd., LOX Tank Cold Helium Sphere Dump	38.0	10-60
A2J29-h	Cmd., Fuel Tank Vent Pilot Valve Open	72.0	30-80
A2J29-i	Cmd., Fuel Tank Vent Valve Boost Close	72.0	30-80
A2J29-q	Cmd., Amb. He. Supply Shutoff Valve Close	28.0	10-60
A2J30-H	Cmd., Cold He. Supply Shutoff Valve Close	1.4K	1.5K max.
	(Same, reverse polarity)	Inf.	Inf.
A2J30-W	Cmd., LOX Vent Valve Open	72.0	30-80
A2J30-X	Cmd., LOX Vent Valve Close	72.0	30-80
A2J30-Y	Cmd., LOX and Fuel Prevalve Emergency Close	72.0	100 max.
	(Same, reverse polarity)	Inf.	Inf.
A2J30-Z	Cmd., LOX and Fuel Chilldown Valve Close	70.0	30-80
A2J30-b	Cmd., LOX Fill & Drain Valve Boost Close	38.0	20-40
A2J30-c	Cmd., LOX Fill & Drain Valve Open	38.0	20-40
A2J30-d	Cmd., Fuel Fill & Drain Valve Boost Close	38.0	20-40
A2J30-e	Cmd., Fuel Fill & Drain Valve Open	38.0	20-40
A2J42-F	Meas., Bus +4D111 Regulation	145.0	100-200
A2J35-y	Meas., Bus +4D141 Regulation	58.0	50-600
A2J6-AA	Sup., 28v +4D119 Talkback Power	100.0	60-100
Reference Designation 463A1			
A5J41-A	Meas., Bus +4D131 Regulation	1400.0	900-1400
A5J41-E	Meas., Bus +4D121 Regulation	2.6K	1.6K min.
A5J53-AA	Sup., 28v +4D119 Forward Talkback Power	75.0	60-100

4.2.9 Stage Power Setup (1B59590 F)

Prior to initiating any other automatic test procedures, the stage power setup procedure verified the capability of the GSE automatic checkout system (ACS) to control power switching to and within the stage, and ensured that the stage forward and aft power distribution system was not subjected to excessive static loads during initial setup sequences. Once the procedure was successfully accomplished, it was used to establish initial conditions during subsequent automatic procedures throughout the VCL testing.

This procedure was initially conducted on 1 August 1967 to verify the operation of the procedure and the equipment. Three point level sensor malfunction

4.2.9 (Continued)

indications were corrected to enable the procedure to be used to establish initial conditions for subsequent automatic procedures. A second acceptance attempt was conducted successfully on 12 September 1967, after completion of the all systems test, and the procedure was accepted on the same date. The following narration and the measurement values shown in Test Data Table 4.2.9.1 are from this last acceptance attempt.

The test started by resetting all of the matrix magnetic latching relays, and verifying that the corresponding command relays were in the proper state. Verification was made that the umbilical connectors were mated. The bus 4D119 talkback power was turned on, and the prelaunch checkout group was turned off. The forward power, bus 4D11 power, and bus 4D41 power, were transferred to external power. The sequencer power, engine control bus power, engine ignition bus power, APS bus 1 and bus 2 power, and propulsion level sensor power, were all verified to be OFF. The range safety system 1 and 2 receiver powers and EBW firing unit powers were all transferred to external and verified to be OFF. The switch selector checkout indication enable and the flight measurement indication enable were both turned on. The bus 4D131 28 vdc power was turned on, the forward bus 1 initial current and voltage were measured, and the forward 1 local sense indication was verified to be OFF. The range safety safe and arm device was verified to be in the SAFE condition.

The switch selector functions were turned off, except that the firing command and charge command functions were reset and the LH_2 and LOX prevalve and chilldown shutoff valve functions were set. The forward bus 1 quiescent current was measured, the PCM system group power was turned on, and the group current was measured. The cold helium supply shutoff valve was closed. The bus 4D111 28 vdc power was turned on, the aft bus 1 current and voltage were measured, and the aft 1 local sense indication was verified to be OFF. The sequencer power was turned on and the sequencer power current was measured. The bus 4D121 28 vdc power was turned on, the forward bus 2 current and voltage were measured, and the forward 2 local sense indication was verified to be OFF. The prelaunch checkout group power was turned on, and the checkout group current was measured. The RACS run mode was turned on, and the forward and aft battery load tests were turned off. The DDAS ground station source selector switch was manually

4.2.9 (Continued)

set to position 1, and the ground station was verified to be in synchronization. The EBW pulse sensor power was turned off.

A series of checks then verified that stage functions were in the proper state. Forty functions were verified to be OFF, and twenty functions were verified to be ON. The LOX and LH_2 prevalves and chilldown shutoff valves were verified to be OPEN, while the vent valves and fill and drain valves were verified to be CLOSED. Measurements were made of the aft 5 volt excitation module voltage and both forward 5 volt excitation module voltages, the range safety EBW firing unit charging voltages, the aft bus 2 voltage, the forward bus 1 and 2 and aft bus 1 and 2 battery simulator voltages, and the component test power voltage. This completed the stage power setup, and established the initial conditions for the other automatic procedures. The computer printout indicated that the switch selector was used 32 times during the last test run.

Engineering comments noted that there were no parts shortages affecting this test procedure. As noted previously, three malfunction indications occurred during the initial attempt because of incorrect point level sensor adjustments. The point level sensor control units were properly adjusted by the level sensor and control unit calibration, H&CO 1B64680, reference paragraph 4.2.12, before further use of the procedure. Two problems encountered during subsequent use of the procedure to prepare for individual automatic tests were covered by FARR's as noted below. No problems were encountered during the final acceptance attempt.

Two FARR's were written against this procedure:

a. FARR A261305 rejected the DP1-B0 multiplexer 404A61A201, P/N 1B62513-533, S/N 16, because the output of subchannel 10 of channel 28 was 2.7 vdc, rather than the required 5.000 $\pm$0.030 vdc. The multiplexer was reconfigurated to P/N 1B52715-505, and resubmitted for repair. A new multiplexer, P/N 1B62513-551, S/N 20, was installed at 404A61A201, and satisfactorily tested by the second issue of the DDAS calibration, H&CO 1B59593, reference paragraph 4.2.13.

b. FARR A261317 noted that on relay module 411A99A10A11, P/N 1A74211-505, S/N 405, contact K-18-2 indicated "open" with forward bus 2 energized. Test point pin H in relay receptacle J-3 indicated zero vdc instead of the required 28.0 $\pm$2.0 vdc. The relay module was removed and a new module, S/N 438, was installed. After retesting confirmed the defect, module, S/N 405, was scrapped.

4.2.9 (Continued)

Nine revisions were made to the procedure for the following:

a. One revision changed the Running Time/Cycle Record paragraph to indicate that the total cycles accumulated by the switch selector during this test would be printed out by both the typewriter and the lineprinter at the end of the test, as the H revision to the STOL executive system, 1B28331, utilized both printout methods.

b. One revision deleted a step to reset the stimuli conditioner at one point during a malfunction subroutine, and added a step to reset the stimuli conditioner by OLSTOL later in the subroutine. This corrected a procedure error, as the stimuli conditioner could not be reset until after the required command tests were performed.

c. Seven revisions made changes to the digital data tape, 1B67312, to correct the decimal point in four scaling factors, to add the actual transducer curves for nineteen functions, to add two omitted functions, and to correct two other functions.

4.2.9.1 Test Data Table, Stage Power Setup

Function	Measurement	Limits
Forward Bus 1 Initial Current (amps)	0.80	20.0 max.
Forward Bus 1 Voltage (vdc)	27.80	28.0 ±2.0
Forward Bus 1 Quiescent Current (amps)	0.00	5.0 max.
PCM System Group Current (amps)	5.60	5.0 ±3.0
Aft Bus 1 Current (amps)	0.60	2.0 max.
Aft Bus 1 Voltage (vdc)	28.12	28.0 ±2.0
Sequencer Power Current (amps)	0.20	3.0 max.
Forward Bus 2 Current (amps)	0.40	2.0 max.
Forward Bus 2 Voltage (vdc)	28.48	28.0 ±2.0
Prelaunch Checkout Group Current (amps)	1.30	4.0 ±4.0
Aft 5 vdc Excitation Module Voltage (vdc)	5.02	5.0 ±0.030
Forward 5 vdc Excitation Module 1 Voltage (vdc)	5.01	5.0 ±0.030
Forward 5 vdc Excitation Module 2 Voltage (vdc)	5.00	5.0 ±0.030
Range Safety 1 EBW Firing Unit Charging Voltage (vdc)	0.00	0.0 ±1.0
Range Safety 2 EBW Firing Unit Charging Voltage (vdc)	0.00	0.0 ±1.0
Aft Bus 2 Voltage (vdc)	0.08	0.0 ±1.0
Forward Bus 1 Battery Simulator Voltage (vdc)	-0.08	0.0 ±1.0
Forward Bus 2 Battery Simulator Voltage (vdc)	0.00	0.0 ±1.0
Aft Bus 1 Battery Simulator Voltage (vdc)	0.00	0.0 ±1.0
Aft Bus 2 Battery Simulator Voltage (vdc)	0.00	0.0 ±1.0
Component Test Power Voltage (vdc)	0.00	0.0 ±1.0

4.2.10 Stage Power Turnoff (1B59591 E)

This procedure shut down the stage power distribution system after the completion of various stage system checkout procedures, and returned the stage to the de-energized condition.

To ensure that the procedure would deactivate the stage power, it was initially conducted on 1 August 1967, after the first application of power to the stage. The first attempt was satisfactory, and the procedure was accepted for stage shut down use on 1 August 1967.

After verification that the talkback, forward bus 1, aft bus 1, and sequencer power were all on, the switch selector functions were turned off. A series of checks verified that the stage functions were in the proper de-energized state, and that the stage bus powers were off. The EBW pulse sensor power was turned off, the range safety receiver power and EBW firing unit power were transferred to external, and the safe and arm device was verified to be in the safe condition. The talkback power was turned off, and the matrix magnetic latching relays were reset, completing the stage power turnoff. The switch selector was used 31 times during the procedure.

Engineering comments noted that there were no parts shortages affecting this procedure. No problems were encountered during the test, and no FARR's were written. Three revisions were made to the procedure for the following:

a. One revision changed the Running Time/Cycle Record paragraph to note that the total cycles accumulated by the switch selector during this procedure would be printed out by both the typewriter and the line-printer, rather than by the lineprinter only.

b. One revision deleted two SIM channel reset commands that were used only at the A45 Beta test stands.

c. One revision changed two malfunction routine typeouts to indicate forward bus 1 malfunction rather than forward battery 1 simulator malfunctions, as an indication of battery simulator malfunction might be incorrect.

4.2.11 Signal Conditioning Setup (1B64681 C)

This procedure calibrated the stage 5 volt and 20 volt excitation modules prior to the use of the stage instrumentation system, and calibrated any items of the stage signal conditioning equipment that were found to be out

4.2.11 (Continued)

of tolerance during testing. The signal conditioning equipment consisted of those items required to convert transducer low level or ac signals to the 0 to 5 vdc form used by the telemetry system, and included dc amplifiers, temperature bridges, frequency to dc converters, and expanded scale voltage monitors. Only the particular items calibrated during this procedure are noted below and in Test Data Table 4.2.11.1. During computer holds, this procedure was also used as required to troubleshoot instrumentation problems.

The procedure was initiated on 1 August 1967, and most of the necessary calibrations were completed by 4 August 1967, after 3 days of activity. The procedure was then held open for use as required during subsequent VCL activity. Additional calibrations were accomplished on 16, 18, and 23 August 1967, and the procedure was closed out and accepted on 18 September 1967. The stage power setup, H&CO 1B59590, was performed prior to any calibration activity, to provide electrical power to the equipment.

Three 5 volt excitation modules were calibrated. The input voltage to each module was verified to be 28 ±1 vdc, and each module was adjusted to obtain a 5 vdc output of 5.000 ±0.005 vdc, a -20 vdc output of -20.000 ±0.005 vdc, and an ac output of 10 ±1 volts peak-to-peak at 2000 ±20 Hz. The final values measured, as shown in the Test Data Table, were all within the above limits. The ac output measurements were made with a test switch in four different positions, and were found to be the same for each position.

Five 20 volt excitation modules were calibrated by adjusting the coarse control and fine control on each module to obtain an output of 20.000 ±0.005 vdc. As shown in the Test Data Table, the final value measured for each module was within the above limits.

A special test was conducted on temperature bridge module 404A62A215, P/N 1A82274-583, S/N 3192, for the heat exchanger helium outlet temperature, measurement C9. This was required to clear FARR A261293, written before VCL checkout started because the module was not tested at the time it was installed. The calibration of the module was verified to be acceptable by determining that the bridge output was within the 0.00 ±0.05 mvdc limits

4.2.11 (Continued)

with a low level calibration input, and within the 24.0 ±0.3 mvdc limits with a high level calibration input. With a 556 ohm ±0.1 percent resistor connected across pins B and C of module connector J1, and with pin B jumpered to pin E, the bridge module output was measured as 30.05 mvdc, within the 30.0 ±0.3 mvdc limits for this condition.

One expanded scale voltage monitor module was calibrated by calibrating the associated dc amplifier. This was the static inverter-converter 5 vdc monitor, measurement M4, expanded scale voltage module 411A61A255, P/N 1A95181-1, S/N 114, and dc amplifier 411A61A254, P/N 1A82395-1, S/N 2349. With a low RACS command on, the dc amplifier zero control was adjusted to obtain a zero output of 0.001 vdc, within the 0.000 ±0.005 vdc limits. With a high RACS command on, the amplifier gain control was adjusted to obtain a gain ouput of 4.003 vdc, within the 4.000 ±0.005 vdc limits.

One breakpoint amplifier was calibrated, amplifier 411A61A213, P/N 1B54875-501, S/N 59, for the RF system channel 1 reflected power, measurement N55. With a run mode RACS command on, the breakpoint amplifier was adjusted for an output of 0.000 ±0.005 vdc. With a low RACS command on, the amplifier was adjusted for an output of 1.003 vdc, within the 1.000 ±0.005 vdc limits. With a high RACS command on, the amplifier was adjusted for an output of 3.998 vdc, within the 4.000 ±0.005 vdc limits. With a run mode RACS command on again, the amplifier bias output was measured as 0.003 vdc, within the 0.000 ±0.005 vdc limits.

Engineering comments noted that there were no parts shortages affecting this test. No major problems were encountered during the test, and no FARR's were written. Thirty-four revisions were made to the procedure, with one of these being voided. The remaining revisions covered the following:

a. One revision added the special test of the temperature bridge module, P/N 1A82274-583, for measurement C9. This was to simulate the rack assembly test of the module, which had not been accomplished.

b. One revision changed the Applicable Drawings list and two test setup figures to show that the channel calibration command decoder assembly should be P/N 1A74053-503 only, rather than P/N 1A74053-1 through -503 as listed. Operational stages used only the -503 assembly.

4.2.11 (Continued)

c. Three revisions changed the Applicable Drawings list to show that the 20 vdc excitation module, P/N 1A74036-1, was a 200 ma unit, rather than a 20 ma unit as listed; to show that the expanded scale voltage monitors were correctly P/N's 1A95181-1 through -501, rather than P/N's 1A94181-1 through -501, as listed; and to add the central calibration command decoder assembly, P/N 1A74051-501, to the list, as it was required for the test.

d. Four revisions changed the End Item Equipment list. The designation "A3 VCL 1" was added to the Model DSV-4B-184A electrical checkout adapter accessory kit, A3 VCL 1, P/N 1B44042-1, as this unit could only be used in the A3 VCL 1 area. The Model DSV-4B-184B electrical checkout adapter accessory kit, A3 VCL 2, P/N 1B44044-1; the Model DSV-4B-184C electrical checkout adapter accessory kit, A45 Beta 1, P/N 1B44043-1; the Model DSV-4B-184D electrical checkout adapter accessory kit, A45 Beta 3, P/N 1B44047-1; and the Model DSV-4B-184E electrical checkout adapter accessory kit, A45 VCL, P/N 1B44048-1, were all added to the list for use in the designated areas. The Model DSV-4B-279 instrumentation checkout unit console assembly, P/N 1B28115-1, was also added to the list, as it was required for parts of this test.

e. One revision added four 5 ohm ± 5 percent 10 watt resistors to the Non-End Item Equipment list, for use during the 5 vdc excitation module calibration.

f. Five revisions modified the 5 vdc excitation module calibration procedure. Breakout box, P/N 1B55546-1, and four 5 ohm ± 5 percent 10 watt resistors were added to the test equipment list and the test setup figure, for use during the 2000 Hz measurement. The steps for measuring the 5 vdc output of the modules were modified to provide proper loading and calibration of this output. A step was added to repeat the calibration for each of the 5 vdc excitation modules listed in the procedure test record table, as all of the 5 vdc and 20 vdc excitation modules had to be calibrated before any other signal conditioning modules were adjusted.

g. One revision added a step to the 20 vdc excitation module calibration to repeat the calibration for each of the 20 vdc modules listed in the procedure test record table, as all of the 5 vdc and 20 vdc excitation modules had to be calibrated before any other signal conditioning modules were adjusted.

h. Two revisions modified the temperature measurement and associated dc amplifier calibration. Dc amplifier, P/N 1A82395-501, was deleted from the calibration, as the -501 amplifiers were used on R&D stages only. At one step a note "VCL only" was added to the instruction for setting the Model 279 RACS command, and a note "Beta only" was added to the instruction for setting the manual checkout decoder switch, as these units were used only at the designated areas.

i. One revision modified the low gain dc amplifier calibration by deleting the output low voltage limits of 1.000 ± 0.005 vdc from the test instructions. The limits varied with different amplifiers, and the proper limits for each amplifier were listed in the procedure test record table.

4.2.11 (Continued)

j. Two revisions modified the expanded scale voltage monitor calibration. The applicable modules were changed to be expanded scale voltage monitor module, P/N's 1A95181-1 and -501, rather than P/N's 1A95181-1 and -503, as the -503 modules were for record only and -501 modules were used as noted in the test record table. The associated dc amplifier output high voltage limits of 4.000 $\pm$0.005 vdc were deleted from the instructions, as the limits varied and the proper limits for each associated amplifier were listed in the procedure test records table.

k. Two revisions modified the 400 Hz expanded scale frequence to dc converter calibration. A 100 kilohm $\pm$1 percent resistor was added to the test equipment list for use at Beta only, to agree with the test setup figure. The required period of the HP205AG generator output was corrected to be 2.43902 $\pm$0.00030 milliseconds, rather than the specified 2.4390 $\pm$0.00030 milliseconds, to provide the omitted last digit.

l. One revision corrected the test setup figure for the calibration of flowmeter frequency converters, P/N 1A89104-505, to clarify the figure and to add an omitted junction symbol to cable assembly, P/N 1B54990-1.

m. One revision added cable assembly, P/N 1B64102-1, to the test equipment list for VCL use only during the calibration of flowmeter frequency converters, P/N's 1B58668-1 and 1B59332-1 and -501, to agree with the test setup figure.

n. One revision corrected the test equipment list for the breakpoint amplifier calibration to show that the Model DSV-4B-279 instrumentation checkout console assembly was correctly P/N 1B28115-1, rather than P/N 1B28118-1 as listed.

o. Seven revisions corrected the test record tables. Measurement C5 was retitled cold helium sphere 3 gas temperature, rather than cold helium sphere temperature, per IP&CL list 1B43565, revision K. For the temperature measurement and associated dc amplifier calibrations on forward rack 411A61, the channel decoder connector references were corrected to be "411A61A216-J1 to 411W221-P1", rather than the incorrectly listed "411A61A216-J1 to 411W211-P1", per drawing 1B53322 revision J. For temperature measurement C159, the temperature bridge module callout was corrected to be P/N 1A82274-581, rather than the incorrectly listed P/N 1A82274-501, per IP&CL 1B43565 revision K. For measurement N18, the decoder line channel callout was corrected to be 01 17, rather than the incorrectly listed 10 17, per the DDAS test requirements drawing 1B63164 revision H. For measurement M23, the output high voltage limits were changed to be 2.285 $\pm$0.005 vdc, rather than the listed 4.000 $\pm$0.005 vdc, per EWO 32166. For measurement M68 on SV stages, the output high voltage limits were corrected to be 4.000 $\pm$0.005 vdc, rather than the incorrectly listed 0.000 $\pm$0.005 vdc, per the DDAS test requirements drawing 1B63164 revision H. For measurement N55, the multiplexer matrix points were corrected to be 647 for the CP1 multiplexer, and 887 for the DP1 multiplexer, rather than the incorrect 888 and 658, respectively, as listed in error.

4.2.11.1 Test Data Table, Signal Conditioning Setup

5 Volt Excitation Module, P/N 1A77310

Reference Location	Dash P/N	S/N	5 vdc Out. (vdc)	-20 vdc Out. (vdc)	ac Output (vpp)	ac Output (Hz)
411A99A33	-503.1	149	4.999	-20.000	9.0	1999
411A98A2	-503.1	172	5.000	-20.000	9.0	2004
404A75A7	-505	161	5.001	-19.999	9.0	2007

20 Volt Excitation Module, P/N 1A74036-1.1

Reference Location	S/N	20 vdc Output (vdc)
411A61A242	312	19.999
404A62A241	303	19.999
404A63A233	267	20.000
404A63A241	300	19.998
404A64A241	301	20.001

4.2.12 Level Sensor and Control Unit Calibration (1B64680 B)

This manual procedure verified that the control units associated with the LOX and LH_2 liquid level, point level, fast fill, and overfill sensors were adjusted for operating points well within the design calibration limits. The particular items involved in this test are noted in Test Data Table 4.2.12.1.

The procedure was satisfactorily accomplished on 1 and 2 August 1967, and was accepted on 2 August 1967. A point level sensor manual checkout assembly, P/N 1B50928-1, and a variable precision capacitor, connected to parallel the sensor, provided capacitance changes to each control unit to simulate sensor wet conditions for calibration, and to determine the control unit operating points.

To establish the control unit operating point, the proper calibration capacitances were provided to simulate the sensor wet condition. These calibration capacitances were 0.7 $\pm$0.01 picofarads for all LH_2 sensors except the LH_2 overfill sensor, which required 1.1 $\pm$0.02 picofarads, and 1.5 $\pm$0.02 picofarads for all LOX sensors except the LOX overfill sensor, which required 2.1 $\pm$0.02 picofarads.

4.2.12 (Continued)

The control unit control point adjustment, R1, was adjusted until the control unit output signal just changed from 0 ± 1 vdc to 28 ± 2 vdc, indicating activation of the control unit output relay.

The capacitance of the precision capacitor was then decreased until the control unit output signal changed to 0 ± 1 vdc, indicating deactivation of the output relay, and then increased until the output signal changed back to 28 ± 2 vdc, indicating reactivation of the output relay. The deactivation and reactivation capacitance values were recorded and appear in the Test Data Table with the appropriate minimum and maximum capacitance limits.

A series of checks then verified the operation of the output relay test function. With the associated sensor disconnected, the output relay was verified to be deactivated under both normal and test conditions. With the sensor connected, the relay was verified to be deactivated under normal conditions and activated under test conditions.

Engineering comments noted that there were no parts shortages that affected this test. FARR A248687, written against this procedure, noted that control unit 404A72A5, P/N 1A68710-511, S/N C10, operated at a capacitance of 0.89 picofarads, outside of the 1.3 to 1.7 picofarads capacitance range limits. A new control unit, P/N 1A68710-511, S/N C44, was installed and satisfactorily tested.

Seven revisions were made to the procedure for the following:

a. Two revisions changed the setup instructions to reference the End Item Equipment paragraphs specifying the electrical checkout adapter accessory kits for use at the A45 Beta I and III test stands; and changed the checkout procedure and test setup figure to connect test cables, P/N 1B54535-501 and -1, to the high and low sides, respectively, of the type 1422CD variable capacitor, rather than connecting the "Hi-Side" and "Lo-Side" of cable, P/N 1B54535-1. This last was to agree with the cable drawing.

b. One revision required the use of test cable, P/N 1B54620-503, rather than test cable, P/N 1B54620-1, to agree with the C revision to the cable drawing, and to permit the test equipment to be outside of the forward skirt; and also changed a function number to be 0550, the vehicle talkback that was to be monitored, rather than 0551, a command relay check that was listed in error.

4.2.12 (Continued)

c. One revision changed two test connections to conform to the proper checkout assembly test jack use. The LOX point level 4 measurement was made at a "red" test jack rather than at an "orange" test jack, and the LOX overfill measurement was made at an "orange" test jack, rather than at a "red" test jack.

d. Two revisions changed the procedure test data table to show that the proper tolerance limits were 1.3 to 1.7 picofarads for the LOX fast fill measurement, rather than 1.9 to 2.3 picofarads as listed, and were 1.9 to 2.3 picofarads for the LOX overfill measurement, rather than 1.3 to 1.7 picofarads as listed.

e. One revision corrected a procedure omission by adding the Model DSV-4B-184A electrical checkout accessory kit A3 VCL 1, P/N 1B44042-1, and the Model DSV-4B-184B electrical checkout accessory kit A3 VCL 2, P/N 1B44044-1, to the End Item Equipment list.

4.2.12.1 Test Data Table, Level Sensor and Control Unit Calibration

	Sensor, P/N 1A68710			Control Unit, P/N 1A68710			Deact. Cap. (pf)		React. Cap. (pf)	
Function	Ref. Loc.	Dash P/N	S/N	Ref. Loc.	Dash P/N	S/N	Meas.	Min.	Meas.	Max.
LH_2 Tank	408			411						
Liq. Lev. L1	MT634	-1	D131	A61A217	-509	C15	0.600	0.5	0.677	0.9
Liq. Lev. L2	MT635	-1	D138	A61A219	-509	C16	0.689	0.5	0.690	0.9
Pt. Lev. 1	A2C1	-507	D71	A92A25	-509	D113	0.668	0.5	0.670	0.9
Pt. Lev. 2	A2C2	-507	D81	A92A26	-509	D112	0.684	0.5	0.688	0.9
Pt. Lev. 3	A2C3	-507	D82	A92A27	-509	D119	0.686	0.5	0.690	0.9
Pt. Lev. 4	A2C4	-507	D86	A61A201	-509	C12	0.638	0.5	0.642	0.9
Fastfill	A2C5	-1	F37	A92A43	-509	C5	0.682	0.5	0.686	0.9
Overfill	*	*	*	A92A24	-509	C9	1.070	0.9	1.074	1.3
LOX Tank	406			404						
Liq. Lev. L4	MT632	-1	D110	A63A221	-511	D118	1.474	1.3	1.480	1.7
Liq. Lev. L5	MT633	-1	D106	A63A206	-511	D65	1.468	1.3	1.472	1.7
Pt. Lev. 1	A2C1	-1	D13	A72A1	-511	D112	1.479	1.3	1.483	1.7
Pt. Lev. 2	A2C2	-1	E94	A72A2	-511	D110	1.462	1.3	1.466	1.7
Pt. Lev. 3	A2C3	-1	E97	A72A3	-511	C15	1.492	1.3	1.496	1.7
Pt. Lev. 4	A2C4	-1	E103	A63A239	-511	D119	1.466	1.3	1.475	1.7
Fastfill	A2C5	-1	D111	A72A5	-511	C44	1.478	1.3	1.479	1.7
Overfill	**	**	**	A72A4	-511	C13	2.080	1.9	2.085	2.3

*Part of LH_2 Mass Probe 408A1, P/N 1A48431-505-009, S/N C1.

**Part of LOX Mass Probe 406A1, P/N 1A48430-509-011, S/N D8.

4.2.13 Digital Data Acquisition System Calibration, Automatic (1B59593 F)

The automatic calibration of the digital data acquisition system (DDAS) was accomplished by this procedure through the insertion of analog signals to the multiplexer inputs and discrete signals to the DDAS bilevel inputs. This test verified that the DDAS was ready to proceed with stage checkout operations. The items involved in this test were the PCM/DDAS assembly, P/N 1A74049-511, S/N 17; the CP1-BO time division multiplexer, P/N 1B62513-531, S/N 33; the DP1-BO time division multiplexer, P/N 1B62513-551, S/N 20; the remote digital submultiplexer (RDSM), P/N 1B52894-1, S/N 12; and the low level remote analog submultiplexer (RASM), P/N 1B54062-503, S/N 41.

Two issues of this procedure were required to complete the DDAS calibration. The procedure was initially started on 2 August 1967, and was completed by the fifth test run on 9 August 1967 after 6 days of activity. This issue of the procedure was accepted on 17 August 1967.

The first three attempts of this issue were not successful because of problems with the PCM/DDAS assembly and incorrect cable connections. After the replacement of the PCM/DDAS assembly by FARR A248688, and the correction of the other problems, the fourth attempt was satisfactorily accomplished on 8 August 1967.

On 9 August 1967, a special test was conducted to isolate intermittent synchronization problems previously encountered with several remote analog submultiplexers. As the problems could not be resolved by bench tests, the test was performed with the various submultiplexers temporarily installed on the stage. After the completion of this special test, remote analog submultiplexer, P/N 1B54062-503, S/N 41, was installed for use, and the fifth procedure attempt was accomplished to perform only the RASM portion of the test.

On 29 August 1967, after the acceptance of the calibration procedure, the DP1-BO multiplexer 404A61A201, P/N 1B62513-533, S/N 16, malfunctioned during the stage power setup for the DDAS automatic procedure. This unit was rejected by FARR A261305, written against the power setup procedure (reference paragraph 4.2.9), and multiplexer, P/N 1B62513-551, S/N 20 was installed. A second issue of the DDAS calibration procedure was accomplished by the first attempt on 30 August 1967, and was accepted on 1 September 1967. Only the

4.2.13 (Continued)

multiplexer flight calibration test and the individual CP1-BO and DP1-BO multiplexer checks were performed by this issue, as only these units were affected by the replacement. The CP1-BO multiplexer was included in the retest because the multiplexer cables had been interchanged during troubleshooting of the malfunction.

The following narration presents the various checks of this procedure in the order of normal programming, rather than in the order of accomplishment, and generally covers the fourth attempt of the first issue. The fifth attempt of the first issue is covered for the RASM test only, and the first attempt of the second issue is covered for the multiplexer flight calibration and individual checks only.

The stage power was turned on per H&CO 1B59590, then initial conditions were established for the stage and DDAS. The 72 kHz bit rate check was made of the PCM data train to ensure it was within tolerance. The 72 kHz bit rate was measured at 72,004 bits per second, well within the 71,975 to 72,025 bits per second limits. Then the 600 kHz VCO test was accomplished by measuring the bandedge frequencies and voltages of the PCM/DDAS VCO output. The upper bandedge frequency was measured as 636.08 kHz at 2.35 vrms, within the acceptable limits of 623.2 kHz to 643.2 kHz at greater than 2.2 vrms. The lower bandedge frequency was measured as 568.9 kHz at 2.32 vrms, within the acceptable limits of 556.8 kHz to 576.8 kHz at greater than 2.2 vrms. The frequency differential was calculated as 67.18 kHz, within the acceptable limits of 70 $\pm$10 kHz.

The next tests performed were the flight calibration and individual checks of the CP1-BO and DP1-BO multiplexers. The outputs of the multiplexer data channels were recorded for each of the calibration and input levels of 0.000, 1.250, 2.500, 3.750, and 5.000 vdc. All measured channels were within the required tolerances.

The RDSM was next verified by inserting ones (20 vdc) and zeros (0 vdc) into the RDSM inputs and checking the output at the computer for a digital word of corresponding ones or zeros. The RASM was then verified by inserting voltages from 0 to 30 millivolts, which were amplified at the output from 0 to

4.2.13 (Continued)

5 volts corresponding to the 0 to 30 millivolts input. All measured outputs for the RDSM and the RASM were within the required tolerances.

A final test measured the PCM/FM transmitter current as 4.9 amperes, within the 4.5 ±3.0 amperes limit. The computer printout indicated that the switch selector was used 20 times during the fourth attempt, 2 times during the fifth attempt RASM test, and 8 times during the second issue multiplexer tests.

Engineering comments noted that there were no parts shortages affecting this test. As noted, problems were encountered with the PCM/DDAS assembly during the test, and the following FARR's were written:

a. FARR A248688 rejected PCM/DDAS assembly, P/N 1A74049-511, S/N 19, for a VCO lower bandedge frequency of 594.685 kHz, outside of the 556.8 to 576.8 kHz limits. A new assembly, S/N 17, was installed. Retest of S/N 19 showed that the VCO would operate properly only with a capacitive load. The assembly was reconfigurated to a Model 301 PCM/DDAS assembly, P/N 1B52720-501, for resubmittal and return to the vendor.

b. FARR A248690 noted that PCM/DDAS assembly, P/N 1A74049-511, S/N 17, had a VCO output of 2.15 vrms, less than the 2.2 vrms minimum requirement. The PCM/DDAS assembly was removed from the stage, the VCO voltage regulator was adjusted to provide the required output amplitude, and the assembly was reinstalled, retested, and accepted for use.

A total of nineteen revisions were made to the first issue of the procedure for the following:

a. Two revisions changed the Applicable Documents paragraph and the end item equipment setup to specify the use of drawing 1B57631-1, Digital Data Acquisition Ground Station, Automatic Test, S-IB-V, VCL, instead of drawing 1B53599-501, Telemetry, GSE, Manual Check - DDAS Ground Station, as the automatic test was required.

b. One revision added drawing 1B38225, Data Acquisition System, Operational, Design Requirements, to the Applicable Douglas Documents list, to conform to test requirements drawing 1B64701.

c. Three revisions changed the nomenclature of three items on the End Item Equipment lists, to conform to title changes of drawings 1B44042, 1B44044, and 1B44048. The retitled items, the Model DSV-4B-184A electrical checkout accessory kit VCL-1 A3, P/N 1B44042-1, the Model DSV-4B-184B electrical checkout accessory kit VCL-2 A3, P/N 1B44044-1, and the Model DSV-4B-184E electrical checkout accessory kit A45-VCL, P/N 1B44048-1, were all previously titled electrical checkout accessory kit.

4.2.13 (Continued)

d. Three revisions deleted items from the End Item Equipment lists because they were not required for this test. The Model DSV-4B-233 remote pneumatic control console, P/N 1A65727-1, and the Model DSV-4B-321 automatic stage checkout pneumatic console -A3, P/N 1A68801-1, were deleted from the A3 VCL 1 and VCL 2 lists, while the Model DSV-4B-233C remote pneumatic control console, SACTO VCL, P/N 1B52840-1, and the Model DSV-4B-321A automatic stage checkout pneumatic console - VCL, SACTO, P/N 1B44643-1, were deleted from the A45 VCL list.

e. Four revisions changed test cable configurations from -1 to -501 at twelve places in the equipment setup instructions, and at nine places in test setup figures. The affected cables were P/N's 1B63118, 1B63119, 1B64103, 1B64104, and 1B55536. The -501 configurations of these cables were required to permit connections to test equipment located outside of the forward skirt.

f. One revision changed a manual power supply setting from 0.0 ±1.0 vdc to be 0.0 ±0.1 vdc at one point in the PCM/DDAS assembly VCO check, to make the tolerance consistent with a previously specified setting.

g. One revision added an omitted minus sign to one terminal of the Model 825A Fluke differential voltmeter symbol in the CP1-BO multiplexer test setup figure, to be compatible with the test requirements drawing.

h. One revision changed the RASM test setup figure to give the correct diagram for SV stages. At connector J2 of the RDSM-RASM checkout kit, P/N 1B64402-1, the connecting plug, P3, was corrected to be plug P3 of test cable, P/N 1B58151-1, for SI stages, and plug P4 of test cable, P/N 1B66556-1, for SV stages.

i. One revision changed a fault subroutine to re-enter the main program one step prior to the designated re-entry point. This was necessary to measure a power supply current and reload a memory cell before continuing the main program.

j. One revision added a note to the PCM/DDAS assembly VCO check manual operations to indicate that it might be necessary to short out power supply leads to obtain zero volts, as the power supply used in the VCL could not always be adjusted to exactly zero volts.

k. One revision provided the instructions for conducting only the RASM test during the fifth test run, as only the reinstalled RASM was to be tested by this run.

Ten revisions were made to the second issue of the procedure. Of these, nine repeated those revisions made to the first issue that were required for accomplishment of the multiplexer tests. One additional revision provided the breakpoint and go to commands required to conduct only the multiplexer flight calibration test and the individual CP1-BO and DP1-BO multiplexer checks, as only the multiplexers were to be tested by this issue.

4.2.14 Propulsion Component Internal Leak Check (1B66929 A)

The propulsion component internal leak check was performed to determine reverse seat leakage (if any) of the pneumatic pressurization system check valves. The test was initiated on 3 August 1967, and was completed and accepted on 4 August 1967.

Reverse seat leakage tests were conducted on the five pneumatic control system check valves, P/N 1B51361-1, S/N's 230, 287, 299, 315, and 350; the ambient helium fill module, P/N 1A57350-507, S/N 235; the LH_2 tank pressurization system check valve, P/N 1B65673-1, S/N 26; and the two LOX tank pressurization system check valves, P/N 1B40824-503, S/N's 131 and 186.

All components tested were installed in the pneumatic control system prior to beginning the test and were reinstalled at the conclusion of the test.

The check valve reverse pressure seat leakage tests were accomplished by connecting a helium source to the outlet of the check valve, using an appropriate 0 to 600 psig or 0 to 5000 psig pressure gauge, and attaching a flowmeter to the inlet of the valve to determine the leakage after 1 minute of pressurization. Check valves, P/N's 1B51361-1 and 1B40824-503, were tested at 1500 $\pm$100 psig, with a 1 scim maximum allowable leakage. Check valve, P/N 1B65673-1, was tested at 500 $\pm$25 psig, with a 10 scim maximum allowable leakage. The ambient helium fill module, P/N 1A57350-507, was tested by pressurizing the module outlet to 1500 $\pm$100 psig, and determing the combined internal leakage at the module inlet and vent. The maximum allowable combined leakage was 10 scim.

The leak check was successfully passed by all components, with zero scim leakage recorded for each check valve tested.

Engineering comments noted that there were no parts shortages affecting this test. No problems were encountered, no FARR's were written, and no revisions were made to the procedure.

4.2.15 Fuel Tank Pressurization System Leak Check (1B59429 B)

This manual procedure leak checked the LH_2 tank pressurization system prior to its use during automatic procedures. The pressurization system consisted of

4.2.15 (Continued)

the ground pressurization line from the aft umbilical and the flight pressurization line from the J-2 engine, both to the pressurization control module; the pressurization line from the control module to the LH_2 tank forward dome; and the tank ullage pressure sensing lines leading to pressure switches and transducers. The flight pressurization line was checked during the J-2 engine system leak check, and not as part of this procedure. The system was pressurized with helium gas for the leak check, and leaks were detected by the use of a USON leak detector or leak detection bubble fluid.

The procedure was accomplished on 4 and 7 August 1967, and was accepted on 8 August 1967. The facilities pneumatic lines were connected to the stage aft umbilical plate, and the LH_2 tank pressurization system was set up for the test. The GSE Model 321 pneumatic console was then set up and pressurized.

The LH_2 prepressurization supply valve was momentarily opened while it was audibly verified that there was no gross leakage in the stage LH_2 tank pressurization system. The supply valve was reopened and the system was pressurized to 400 $\pm$50 psia. Leak checks were then conducted on all connections and lines of the system. The LH_2 tank pressurization module check valve reverse seat leakage was measured as zero scim, meeting the 150 scim maximum leakage limit. The system pressure was reduced to 15 $\pm$5 psig, and the check valve reverse seat leakage was again measured as zero scim, meeting the 20 scim maximum leakage limit for this pressure.

The LH_2 system checkout supply valve was opened, it was audibly verified that there were no gross leakages, and the pressure switch checkout supply lines were pressurized and leak checked. At the completion of this check, the system was vented and the test setups were removed.

Engineering comments noted that there were no parts shortages affecting this test. One area of leakage was found at the B-nut connecting pipe assembly, P/N 1B64112-1, to the umbilical disconnect. FARR A248692, written to cover this, noted that the disconnect, P/N 7851861-1, S/N 56, had several nicks on the pipe assembly flare seating surface of the disconnect outlet side, and a nick in the leading edge of the disconnect inlet side. The damaged areas were refinished to an acceptable condition, correcting the leakage.

4.2.15 (Continued)

Two revisions were made to the procedure for the following:

a. One revision added the reverse seat leakage test of the LH_2 tank pressurization module internal check valve.

b. One revision increased the system pressure to be 400 ±50 psia for the leak checks, rather than 300 ±20 psia as specified. This was to comply with current design requirements.

4.2.16 Propulsion System Control Console/Stage Compatibility (1B59427 B)

The Model DSV-4B-234 propulsion system control console, P/N 1A65728-1, remotely controlled and monitored the stage propulsion system during automatic and manual checkout operations in the VCL. Prior to using the console, this procedure ensured that the stage-mounted solenoid valves responded properly when the various electrical command switches on the console were operated. The checkout consisted of separate tests on valves in the forward skirt area, the aft skirt area, and the thrust structure area.

The procedure was conducted on 7 August 1967, and was accepted on 10 August 1967. The proper actuation and deactuation of the solenoid valves was verified by listening for valve actuation at the appropriate modules, and it was verified that the correct indicator lights came on at the Mainstage Propulsion Manual Control Panel of the control console.

In the forward skirt area, the valves checked were the main fuel tank vent valve open/close solenoid valve 411A2L1 and boost close solenoid valve 411A2L2; and the main fuel tank bi-directional vent valve flight position solenoid valve 411A30L2 and ground position solenoid valve 411A30L1.

In the aft skirt area, the valves checked were the main fuel tank fill and drain valve open/close solenoid valve 404A44L1 and boost close solenoid valve 404A44L2; the main oxidizer tank fill and drain valve open/close solenoid valve 404A9L1 and boost close solenoid valve 404A9L2; the LH_2 and LOX chilldown shutoff valve close/open solenoid valve 404A43L1; and the LH_2 and LOX prevalve close/open solenoid valve 404A43L2.

In the thrust structure area, the valves checked were the main oxidizer tank vent valve open/close solenoid valve 403A75A1L1 and boost close solenoid

4.2.16 (Continued)

valve 403A75A1L2; the control helium shutoff valve close/open solenoid valve 403A73A1L2 and the start tank vent valve open/close solenoid valve 403A73A1L1, both in the pneumatic control module; the ambient helium sphere dump valve open/close solenoid valve 403A74A4L1 in the ambient helium fill module; the cold helium dump valve open/close solenoid valve 403A74A2L1 in the cold helium fill module; the cold helium shutoff valve open/close solenoid valves 403A74A1L1 and 403A74A1L3 in the LOX tank pressurization control module; and the engine control bottle vent valve open/close solenoid valve in the engine pneumatic power package. All of the valves responded properly to the signals from the propulsion system control console.

Engineering comments noted that there were no parts shortages affecting this test. No problems were encountered during the test, no FARR's were written, and no revisions were made to the procedure.

4.2.17 Pneumatic Control System Leak Check (1B59430 B)

This manual procedure checked the components of the pneumatic control system to verify that there was no leakage in excess of design specifications. The pneumatic control system provided gaseous helium for the stage purge system and pneumatically operated valves; and included a helium sphere, a helium fill module, a pneumatic control module, a plenum chamber, six actuation control modules, an engine pump purge module, a LOX chilldown pump purge module, the various pneumatic valves, and the associated plumbing and electrical circuitry.

Initiated on 7 August 1967, the procedure was completed on 16 August 1967 after 6 days of activity, and was accepted on 8 September 1967. In general, the test was accomplished by pressurizing the pneumatic control system with gaseous helium, and using a USON leak detector as the primary method of detecting leakage. Leak test bubble fluid was used when required as a secondary detection method, and gross leakage was located by listening for audible escaping gas.

The stage test configuration was established by capping various supply and purge lines to isolate the pneumatic control system. The APS helium fill

4.2.17 (Continued)

lines were pressurized to 1500 ±100 psia and leak checked. The engine pump purge pressure switch and the LOX chilldown pump purge pressure switch were checked by applying pressure to the engine pump purge control module outlet line and the LOX switch sensing line. The switches were individually pressurized and depressurized three times each, while the switch pickup and dropout pressures were measured. The switch deadbands were then determined as the difference between these pressures. The results of these checks appear in Test Data Table 4.2.17.1.

The pneumatic control helium sphere was incrementally pressurized to 1750 +0, -100 psia, while it was audibly verified that there was no gross leakage. This pressure was maintained for 3 minutes for a sphere integrity check, and the sphere was then vented to the 1500 ±100 psia required for subsequent leak checks.

Leak checks were then conducted on all pneumatic control system supply and purge lines, and on the following system components: the pneumatic control module; the engine pump purge control module; the LOX chilldown pump and the pump purge control module; the LOX and LH_2 prevalves and chilldown shutoff valves, and the actuation control module for these valves; the LOX and LH_2 vent and relief valves and their actuation control modules; the LOX and LH_2 fill and drain valves and their actuation control modules; the directional control valve and its actuation control module; and the system pressure switches and transducers. The leaks found and corrected during these checks are noted below.

Seal leakage rates were measured at the vent ports on the ambient helium fill module, all actuation control modules, and the pneumatic control module; at the housing and piston vents of the pneumatic valves; and at the LOX chilldown pump overboard vent, relief valve, and dump valve. These leakage rates were all zero scim or sccm, except for two. The LOX fill and drain valve position switch housing vent leaked 32 sccm, within the 300 sccm allowable limit, and the LOX chilldown pump seal drain overboard vent leaked 4 scim, within the 8 scim allowable limit.

4.2.17 (Continued)

A system pressure decay test showed that the pneumatic control sphere pressure dropped from 1445 psig to 1430 psig during a 30 minute period with the pneumatic valves deactuated, and droppped from 1415 psig to 1397 psig during a 30 minute period with the pneumatic valves all actuated. These pressure decays were acceptable.

The purge system restrictor orifice flow was measured as 9.75 scim with the pneumatic control sphere pressurized to 415 ±25 psig, as 13.1 scim with the sphere pressurized to 600 ±25 psig, and as 13.3 scim when the pneumatic control shutoff valve was opened. These flow rates were all acceptable. The purge system was leak checked as a final test, and the pneumatic control sphere and all pressurized lines were vented. The pneumatic control system was returned to the pre-test configuration to complete the procedure.

Engineering comments noted that there were no parts shortages affecting this test. The following leaks were found and corrected, and three FARR's were written as noted:

a. Leakage was found at five B-nuts on the system. All of these leaks were satisfactorily corrected without FARR action, and the B-nuts were rechecked and accepted.

b. The pneumatic power control module, P/N 1B43657-509, S/N 16, was rejected by FARR A248694 for a 590 psig lockup pressure and a greater than 10,000 scim flow after lockup, both exceeding the maximum limits of 550 psig and 25 scim. The unit was retained for test use until replacement became available, and was then rejected by FARR A261314 for the same reason. A new control module, S/N 1029, was installed, satisfactorily tested, and accepted for use.

c. The engine pump purge control module, P/N 1B56804-1, S/N 1, was rejected by FARR A261311 for a 22 sccm leak through the component leak check port, exceeding the 1 sccm maximum limit. A new module, S/N 14, was installed, satisfactorily tested, and accepted for use.

Eight revisions were made to the procedure for the following:

a. One revision changed the method of making the engine pump purge and LOX chilldown pump purge pressure switch pickup and dropout pressure measurements, to simplify the procedure and to avoid disconnecting the switch electrical connectors.

4.2.17 (Continued)

b. Two revisions added a step to vent the control helium sphere to 245 +10, -20 psig before conducting the start tank vent solenoid valve seat leakage checks on the pneumatic control module, to proved a 4 to 1 safety factor on the vent valve; and changed the acceptable limit on this leakage to be 10 scim rather than 1 scim, to correct a typing error.

c. One revision corrected a procedure omission by adding instructions to close the purge hand valves after reconnecting the purge lines during the post-test operations.

d. One revision added several steps to provide a proper sequential leak check of the LOX chilldown pump purge system including the redundant purge lines.

e. One revision changed a pipe assembly designation to be P/N 1B64600-1 rather than P/N 1B64400-1, to correct a procedure error.

f. One revision changed the LH_2 vent and relief valve leak check to clarify the operation and to reflect the current design requirements.

g. One revision added a series of steps to verify the purge system restrictor orifice flow capacity.

4.2.17.1 Test Data Table, Pneumatic Control System Leak Check

Pressure Switch Checks

Function	1st Run	2nd Run	3rd Run	Limits
Engine Pump Purge Pressure Switch				
Pickup Pressure (psig)	107.0	107.0	107.0	115.3 Max.
Dropout Pressure (psig)	95.0	95.0	95.0	90.3 Min.
Deadband Pressure (psi)	12.0	12.0	12.0	5.0 Min.
LOX Chilldown Pump Purge Pressure Switch				
Pickup Pressure (psig)	37.9	37.6	37.6	39.3 Max.
Dropout Pressure (psig)	35.0	35.0	35.0	34.3 Min.
Deadband Pressure (psi)	2.9	2.6	2.6	0.5 Min.

4.2.18 Digital Data Acquisition System (1B59594 G)

The digital data acquisition system (DDAS) test provided operational status verification of data channels on the stage, except certain data channels which were tested during specific system tests. The outputs of these channels were checked by the D924A computer and found to be within the specified tolerances.

4.2.18 (Continued)

The proper operation of all signal conditioning units and associated amplifiers, the command calibration channel decoder assembly, and the transmitter output and the antenna system, were also checked by the computer.

Items tested by this procedure consisted of the PCM/DDAS assembly, P/N 1A74049 -511, S/N 17; the CP1-BO time division multiplexer, P/N 1B62513-531, S/N 33; the DP1-BO time division multiplexer, P/N 1B62513-551, S/N 20; the remote digital submultiplexer (RDSM), P/N 1B52894-1, S/N 12; and the low level remote analog submultiplexer (RASM), P/N 1B54062-503, S/N 41.

The first attempt to run the test procedure was on 8 August 1967. Eleven attempts were required before the test was successfully completed on 8 September 1967. The procedure was active for 17 days, which included trouble-shooting of the malfunctions encountered, and was accepted on 13 September 1967.

The discussion that follows covers in general the conduct of the test, the malfunctions encountered prior to a successful run, and the revisions to the procedure.

All channels having a calibration capability were compared one at a time, by the computer, to the tolerance limits. Transducer analog outputs were signal conditioned and fed to the multiplexers. The multiplexer unit input channels were electronically sampled at a given rate, then these samples were fed into the digital data acquisition assembly (DDAA). The DDAA received these output samples through a time share gate and converted them to 10 bit binary coded words. The DDAA output was fed into the ground station and the PCM RF transmitter by coaxial cable. The ground station output was fed into the computer for tolerance verification.

High mode and/or low mode calibration command signals were provided, by the remote automatic calibration systems (RACS), by binary coded ground commands to a central calibration command decoder assembly in the stage. These signals were fed into the signal conditioning modules to provide channel operation verification in the DDAS.

4.2.18 (Continued)

Channels without RACS capability and spare channels were tested by comparing the end item outputs, at ambient conditions, to tolerance limits. Ambient conditions were defined as 70 degrees Fahrenheit at 14.7 psi, and for bilevel parameters, the normal state of valves or switches during the performance of this test. All channel outputs were measured and the output printed out.

Special channel tests at 400 Hz, 100 Hz and 1500 Hz were performed, in the order given, following completion of the DP1-BO multiplexer tests. The 400 Hz test checked the static inverter-converter frequency, the LOX circulation pump flow rate, and the LH_2 circulation pump flow rate. LOX and LH_2 flowmeter test at 100 Hz followed the 400 Hz test. The LOX and LH_2 pump speeds were checked using the 1500 Hz test input. The indications displayed during the special channel tests were as expected.

The antenna system operations were tested using the telemetry outputs as the measurements instead of the hardwire measurements used in the antenna procedure.

The first attempt was not acceptable because of malfunctions and hardware problems. Thirteen transducer cables were disconnected at the time of this attempt, to permit inspection of the connectors per WRO 3714. The cables were all reconnected for subsequent attempts. The remote analog submultiplexer, the dc amplifier for measurement C169, and the pressure transducers for measurements D178 and D577, were rejected by FARR's A248693, A248696, A261310, and A261312, noted below. Replacement parts were installed for all of these except the measurement D577 transducer, which was retained until a part became available.

The second attempt was not acceptable because of numerous malfunctions. Measurements C207, D237, M4, and M68 were out-of-tolerance, all umbilical measurements failed, and several E03 typeouts occurred because the ground station was set for crystal rather than VCO operation. All of these problems were corrected for the next attempt. Measurement D577 was again out-of-tolerance because the transducer had not been replaced. Another transducer was installed before the next attempt. All of the multiplexer full scale

4.2.18 (Continued)

reference channels were out-of-tolerance because of a malfunction of the aft 5 vdc excitation module. This module was to be replaced when another unit became available.

The third attempt was not acceptable because of malfunctions of measurements C52, C207, D63, D237, M4, M12, M68, and all umbilical measurements. These problems were corrected for the next attempt. The CP1-BO multiplexer full scale reference channels were again out-of-tolerance because of the aft 5 vdc excitation module. The excitation module was rejected by FARR A261315, and a new module was installed. A channel calibration command decoder assembly was rejected by FARR A261316, and replaced by a new unit.

The fourth attempt was not acceptable because of several malfunctions. The replacement aft 5 vdc excitation module was out-of-tolerance, and was readjusted for the next attempt. Measurement D545 indicated a negative common bulkhead pressure on the hardline transmission because the amplifier connectors were switched. The transducer kit for this measurement was rejected by FARR A261318 and replaced. The LOX and LH_2 ullage pressures, measurements D576 and D577, were out-of-tolerance with nominal calibration curves, but were acceptable with the actual transducer calibration curves.

The fifth attempt was not acceptable because of three malfunctions. A low RACS test failure of measurement N55 was corrected by adjusting the breakpoint amplifier. The measurement D237 ambient reading was acceptable after the actual curve values were entered. FARR A261322 rejected the transducer kit for measurement D183 because of a low RACS test failure. Another transducer kit was to be installed.

The sixth attempt was not acceptable because of several malfunctions. Measurements D42, G1; and L7 were out-of-tolerance because the pitch hydraulic actuator, P/N 1A66248-507, had been removed because of leakage, as noted in paragraph 4.2.28. Measurement D183 failed again, as the replacement transducer kit had not been installed at the time of this attempt. Both the pitch actuator and the transducer kit were installed before the next attempt.

4.2.18 (Continued)

Measurement D577 failed because of pressure trapped in a line. FARR A261323 rejected the transducer kit for measurement D545 because of a high RACS test failure. Another transducer kit was installed.

The seventh attempt was not acceptable because measurements D1, D17, D178, and D577 were out-of-tolerance. Adjustments were made to correct these problems. The DP1-BO multiplexer was rejected and replaced during this attempt, as noted in paragraph 4.2.9.

The eighth attempt was not acceptable because measurement C208 would not change from ambient to the high calibration condition. FARR A261306 rejected the channel calibration command decoder for this measurement, and a new decoder was installed.

The ninth attempt was not acceptable because of four measurement malfunctions. The tolerance on measurement D10 was increased to prevent malfunction indications during subsequent attempts. FARR A261307 rejected the Rocketdyne transducers for measurements D1, D17, and D18, for out-of-tolerance readings. As replacement transducers were not immediately available, the DDAS procedure could not be completed. By customer agreement, the all systems test was accomplished before the DDAS procedure was continued, reference paragraph 4.2.32.

After the Rocketdyne transducers were replaced, the tenth attempt was conducted, but was not acceptable because of minor problems with VSWR measurements. Channel decoder assembly, P/N 1A74053-503, S/N 233, was replaced by S/N 331 during this attempt, as noted in paragraph 4.2.32.

The eleventh attempt was successfully completed with only two malfunction indications, both for measurement D18. These were both acceptable, as the computer was looking for an incorrect expected pressure.

Engineering comments noted the previously mentioned parts shortages, with all shortages corrected before the end of the test. It was also noted that three J-2 engine transducers, all P/N NA5-27323T3, were non-flight items. Another comment recorded the new ambient values for the Rocketdyne replacement

4.2.18 (Continued)

transducers for measurements D1, D17, and D18. Two other comments noted that computer printouts for VSWR ratios incorrectly included the unit of "watts", and that the summed bi-level channel identifications incorrectly printed a semicolon prior to spare test printouts. Both of these problems were program errors that required correction.

As noted, eleven FARR's were written against this procedure for the following:

a. FARR A248693 rejected remote analog submultiplexer 404A60A201, P/N 1B54062-503, S/N 42, because it would not synchronize with 28.0 ±2.0 vdc power applied, as noted by IIS 366484. Another unit, S/N 41, was installed and accepted.

b. FARR A248696 rejected dc amplifier 404A62A208, P/N 1A82395-1, S/N 2389, for measurement C169, because the gain control would not adjust the output to the required 4.000 ±0.005 vdc. The maximum output was 3.402 vdc, as noted on IIS 365795. A new amplifier, S/N 2274, was installed and accepted.

c. FARR A261306 rejected channel calibration decoder assembly 404A62A214, P/N 1A74053-503, S/N 305, because the measurement C208 reading did not change from ambient during a high RACS calibration. A replacement assembly, S/N 360, was installed and accepted.

d. FARR A261307 rejected three Rocketdyne transducers for out-of-tolerance readings under ambient and RACS calibration conditions. The transducers were 4013MTP3, P/N NA5-27412T10T, S/N 5012A, for measurement D1; 4013MTP5, P/N NA5-27412T15T, S/N 5948A, for measurement D17; and 4013MTP52, P/N NA5-27412T7LT, S/N 5887A, for measurement D18. Replacement transducers were installed for these measurements and accepted for use.

e. FARR A261310 rejected pressure transducer 410MT614, P/N 1B43320-601, S/N 44-5, for measurement D178, because the output did not meet the calibration curve within 2 percent of full scale, as noted by IIS 366484. A new transducer, S/N 5-13, was installed and accepted.

f. FARR A261312 rejected pressure transducer 403MT724, P/N 1B43324-601, S/N 61-1, for measurement D577, because the ambient pressure output was 15.695 psia, outside of the 14.0 ±1.0 psia limits, as noted by IIS 366484. Another transducer, S/N 60-1, was installed and accepted.

g. FARR A261315 rejected the aft 5 vdc excitation module, P/N 1A77310-505, S/N 118, for a 10 to 20 millivolt out-of-tolerance drift over a 30 minute period, as noted by IIS 365966. A new module, S/N 161, was installed, and was accepted for use after being readjusted to the 5.000 ±0.005 vdc required output.

4.2.18 (Continued)

h. FARR A261316 rejected channel calibration command decoder assembly 411A61A216, P/N 1A74053-503, S/N 344, for random failures during RACS calibrations, as noted on IIS 365968. A new decoder assembly, S/N 340, was installed and accepted.

i. FARR A261318 rejected transducer kit 404MT628, P/N 1B40242-501, S/N 501-20, for measurement D545, because the output was -0.300 vdc when it should have been 3.000 vdc, as noted by IIS 365972. It was found that the transducer cable and the stage wiring cable were crossed during installation of the transducer amplifier. A new transducer kit, S/N 501-22, was installed (reference FARR A261323).

j. FARR A261322 rejected the transducer kit, P/N 1B40242-555, S/N 555-14, for measurement D183, for a low RACS test output of 0.005 vdc, outside the 1.000 ±0.100 vdc limits, as noted by IIS 365972. A new transducer kit, S/N 555-24, was installed and accepted.

k. FARR A261323 rejected the transducer kit, P/N 1B40242-501, S/N 501-22, for measurement D545, for a high RACS test output of 0.024 vdc, outside the 4.000 ±0.100 vdc limits, as noted by IIS 365972. A new transducer kit, S/N 501-25, was installed and accepted.

Seventeen revisions were made to the procedure for the following:

a. Eight revisions changed expected values and tolerances, to provide the correct requirements.

b. One revision set the DDAS ground station frequency counter to a sensitivity of 0.1, rather than 1, to provide the required sensitivity.

c. One revision changed the item names of the DSV-4B-184A and DSV-4B-184B to be electrical checkout accessory kit, VCL-1 A3 and VCL-2 A3, respectively.

d. Two revisions corrected the Rocketdyne pressure transducer parameter table to show that one measurement was D86 rather than D87 as listed, and to delete all ambient values as these were programmed into the test.

e. One revision provided that Rocketdyne calibration values obtained from the engine logbook were to be entered into the Rocketdyne pressure transducer parameter table, rather than DAC data engineering values, as the calibration values were required.

f. One revision provided that the expected value results from the printout should be entered into the Rocketdyne pressure transducer parameter table for comparison, rather than the measured results.

g. One revision set a breakpoint at the start of the transmitter output power test subroutine, to permit verification that the transmitter forward power was between 15 watts and 28.5 watts, to meet specification requirements and GSE tolerances.

4.2.18 (Continued)

h. One revision provided instructions for correcting the flowmeter frequency converter expected value to correspond to an input frequency greater than 0.25 percent in error from 400 Hz.

i. One revision corrected three program errors, to verify the condition of the proper control flag.

4.2.19 Power Distribution System (1B59592 F)

The automatic checkout of the stage power distribution system verified the capability of the GSE to control power switching to and within the stage, and determined that static loads within the stage were not excessive. The procedure verified that particular stage relays were energized or de-energized as required, and that bilevel talkback indications were received at the GSE. Static loading of the various stage systems or assemblies was determined by measuring the GSE supply current before and after turn-on of the system. All electrical components on the stage were involved in this test, including the point level sensors, the propellant utilization system, the auxiliary propulsion system, the J-2 engine ignition bus, the stage telemetry system, the stage power buses, the LOX and LH_2 chilldown inverters, and the external to internal power transfer system.

Initiated on 8 August 1967, the procedure was accomplished by the second attempt on the same date, and was accepted on 9 August 1967. The first attempt was terminated by program errors which were corrected for the second attempt. The values measured during the successful second attempt are shown in Test Data Table 4.2.19.1.

The stage power setup, H&CO 1B59590, was accomplished, and initial conditions were established for the test. To verify power supply and stage bus operations, measurements were made of the engine control bus current and voltage; the APS bus current; the engine ignition bus current and voltage with the bus on, and the voltage with the bus off; and the component test power current and voltage with the power on. With the component test power off, the test power voltage was verified to be 0.0 ±2.0 vdc. For a check of the emergency detection systems (EDS), it was verified that the EDS 2 engine cutoff signal turned off the engine control bus power and prevented it from being turned back on, and

4.2.19 (Continued)

also turned on the instrument unit range safety 1 EBW firing unit arm and engine cutoff signal. The engine control bus voltage was measured after this check with the bus power turned back on. Verification was then made that the EDS 1 engine cutoff signal turned on the non-programmed engine cutoff signal and the AO multiplexer engine cutoff signal indication; and that with the EDS 1 signal turned off, the engine ready bypass turned off both cutoff indications.

For a point level sensor test, the propellant level sensor power current was measured, and each of the four LH_2 tank and four LOX tank point level sensors were verified to respond properly within 300 milliseconds to simulated wet condition on commands. A series of checks then verified that a dry condition indication from any two point level sensors in either tank, obtained by simulated wet condition off commands, resulted in the required engine cutoff signal. For the dry condition of LOX tank point level sensors 1 and 2, the engine cutoff LOX depletion timer value was measured to determine the cutoff signal delay time. Each of the point level sensors was then verified to respond properly within 300 milliseconds to simulated wet condition off commands.

Verification was made that the engine cutoff command turned on the AO multiplexer engine cutoff signal indication, the engine cutoff command indication, and the engine cutoff, but did not turn on the non-programmed engine cutoff indication. With the engine cutoff command turned off, it was verified that the engine cutoff command indication was off while the multiplexer engine cutoff indication and the engine cutoff remained on until turned off by the engine ready bypass.

The propellant utilization inverter and electrical power current was measured while the power was momentarily turned on. The PCM RF assembly power current was then measured, and the PCM/FM transmitter output power was measured through both the AO and BO multiplexers. With the telemetry RF silence command turned on, the RF group was verified to be off, the PCM/FM transmitter output power was measured through the AO multiplexer, and the switch selector output monitor

4.2.19 (Continued)

voltage was measured with the PCM RF assembly power and read commands 1 and 2 turned on. With the telemetry RF silence command turned off, the RF group was verified to be on, and the PCM/FM transmitter output power was again measured through the AO multiplexer.

The rate gyro voltages were manually verified to be 28.0 $\pm$2.0 vdc with the gyro turned on, and 0.0 $\pm$2.0 vdc with the gyro turned off. The environmental control group current was measured while the group was momentarily turned on. The aft bus 2 current and voltage were then measured, and the aft bus 2 power supply local sense indication was verified to be off.

For the chilldown inverter tests, the chilldown pump simulator was connected to the LOX and LH_2 chilldown inverters, and, for each inverter, measurements were made of the input current and output voltages, and the inverter operating frequencies were manually measured.

A series of checks then verified the operation of the external/internal transfer system for the forward and aft buses. The battery simulator voltages and the electrical support equipment load bank voltages were measured first. The power bus voltages were then measured with the buses transferred to internal, and the bus local sense indications were verified to be off. The bus voltages were measured again with the buses transferred back to external, and the battery simulator voltages were measured with the simulators turned off. The aft bus 2 voltage was then measured with the bus power supply turned off.

A series of checks then verified that the switch selector register was operating properly, and that the instrument unit 28 vdc power supplies were all on. The range safety receiver currents were measured with the receivers transferred to external power and momentarily turned on. The range safety system EBW firing units were verified to be on when they were transferred to external power and momentarily turned on. This completed the power distribution system test. The computer printout indicated that the range safety receivers and decoders had accumulated 9.327 seconds of running time during this attempt, and that the switch selector had been used 29 times.

4.2.19 (Continued)

Engineering comments noted that there were no parts shortages affecting this test. No problems were encountered involving stage hardware, and no FARR's were written. Eight revisions were made to the procedure for the following:

a. One revision added the Model DSV-4B-749 chilldown pump simulators, P/N 1B63210-1, to the Mandatory End Items list, for use during the test.

b. One revision added steps to three malfunction subroutines to turn off the environmental control group, or the range safety receiver 1 or 2 external power, to ensure that these items were off before repeating the test after a malfunction.

c. One revision changed ten "type" statements to be "print" statements, so that normal test data would appear on the line printer output rather than on the typewriter output.

d. Two revisions provided instructions for manually checking the LOX and LH_2 chilldown inverter operating frequencies, as a design problem with the Model DSV-4B-131 response signal conditioner, P/N 1A59947-1, prevented an automatic frequency check.

e. One revision added manual steps to set up the chilldown inverters by connecting input power cables 404W7P10 and 404W7P9 to the LOX chilldown inverter connector 404A74A1J1 and the LH_2 chilldown inverter connector 404A74A2J1, respectively. To provide protection for the inverters, the power cables were disconnected and stowed when the stage was received in the VCL, and whenever use of the inverters was not required.

f. Two revisions corrected program errors that had caused the termination of the first test attempt. The instrument unit range safety 2 EBW firing unit arm and engine cutoff signal was verified to be off, rather than on, at one point in the program; and the tolerance on the chilldown inverter hardwire phase voltage measurements was to be +2, -4.5 vdc, rather than ± 3 vdc, at eight places in the program. The tolerance change was required because the inverters were set up under "no load" conditions, and the 100 kilohm load supplied by the chilldown pump simulators lowered the inverter output.

4.2.19.1 Test Data Table, Power Distribution System

Function	Measurement	Limits
Engine Control Bus Current (amps)	0.200	2.0 $\pm$2.0
Engine Control Bus Voltage (vdc)	28.398	28.0 $\pm$2.0
APS Bus Current (amps)	0.500	1.5 $\pm$3.0
Engine Ignition Bus Current (amps)	-0.300	0.0 $\pm$2.0
Engine Ignition Bus Voltage, Bus On (vdc)	28.307	28.0 $\pm$2.0
Engine Ignition Bus Voltage, Bus Off (vdc)	0.030	0.0 $\pm$2.0
Component Test Power Current (amps)	0.100	0.0 $\pm$2.0

4.2.19.1 (Continued)

Function	Measurement	Limits
Component Test Power Voltage (vdc)	28.399	28.0 ±2.0
Engine Control Bus Voltage, EDS 2 Off (vdc)	28.398	28.0 ±2.0
Propellant Level Sensor Power Current (amps)	0.000	1.0 ±2.0
Engine Cutoff LOX Depletion Timer (seconds)	0.552	0.560 ±0.025
PU Inverter and Electrical Power Current (amps)	4.300	3.0 ±2.0
PCM RF Assembly Power Current (amps)	5.300	4.5 ±3.0
PCM/FM Transmitter Output Power, AO (watts)	24.835	10.0 min.
PCM/FM Transmitter Output Power, BO (watts)	24.805	10.0 min.
PCM/FM Transmitter Output Power (RF Silence On) (watts)	-0.089	0.0 ±2.0
Switch Selector Output Monitor (vdc)	2.215	2.0 ±1.0
PCM/FM Transmitter Output Power (RF Silence Off) (watts)	23.794	10.0 min.
Environmental Control Group Current (amps)	0.000	0.0 ±2.0
Aft Bus 2 Current (amps)	0.399	5.0 max.
Aft Bus 2 Voltage (vdc)	55.518	56.0 ±4.0

Childown Inverter Tests

Function	LOX Inv.	LH_2 Inv.	Limits
Inverter Current (amps)	21.399	22.6	22.0 ±5.0
Phase AB Voltage (vac)	51.349	51.349	55.5, +2.0, -4.5
Phase AC Voltage (vac)	51.283	51.414	55.5, +2.0, -4.5
Phase A1B1 Voltage (vac)	51.414	51.414	55.5, +2.0, -4.5
Phase A1C1 Voltage (vac)	51.414	51.283	55.5, +2.0, -4.5
Frequency (Hz)	402.0	399.8	400.0 ±4.0

Function	Measurement	Limits
Forward Bus 1 Battery Simulator Voltage (vdc)	29.12	28.0 ±2.0
Forward Bus 2 Battery Simulator Voltage (vdc)	28.48	28.0 ±2.0
Aft Bus 1 Battery Simulator Voltage (vdc)	28.44	28.0 ±2.0
Aft Bus 2 Battery Simulator Voltage (vdc)	55.44	56.0 ±4.0
Bus 4D20 ESE Load Bank Voltage (vdc)	0.04	0.0 ±1.0
Bus 4D40 ESE Load Bank Voltage (vdc)	0.08	0.0 ±1.0
Bus 4D30 ESE Load Bank Voltage (vdc)	0.00	0.0 ±1.0
Bus 4D10 ESE Load Bank Voltage (vdc)	0.00	0.0 ±1.0
Forward Bus 1 Internal Voltage (vdc)	29.04	28.0 ±2.0
Forward Bus 2 Internal Voltage (vdc)	28.40	28.0 ±2.0
Aft Bus 1 Internal Voltage (vdc)	28.44	28.0 ±2.0
Aft Bus 2 Internal Voltage (vdc)	55.52	56.0 ±4.0
Forward Bus 1 External Voltage (vdc)	29.04	28.0 ±2.0
Forward Bus 2 External Voltage (vdc)	28.56	28.0 ±2.0
Aft Bus 1 External Voltage (vdc)	28.32	28.0 ±2.0
Aft Bus 2 External Voltage (vdc)	55.52	56.0 ±4.0

4.2.19.1 (Continued)

Function	Measurement	Limits
Forward Bus 1 Battery Simulator Voltage (vdc)	0.16	0.0 ±1.0
Forward Bus 2 Battery Simulator Voltage (vdc)	0.04	0.0 ±1.0
Aft Bus 1 Battery Simulator Voltage (vdc)	-0.04	0.0 ±1.0
Aft Bus 2 Battery Simulator Voltage (vdc)	0.16	0.0 ±1.0
Aft Bus 2 Voltage (vdc)	0.00	0.0 ±1.0
Range Safety Receiver 1 Current (amps)	0.250	0.0 ±2.0
Range Safety Receiver 2 Current (amps)	0.500	0.0 ±2.0

4.2.20 Cold Helium System Leak Check (1B59431 B)

This manual leak and functional check verified the integrity of the cold helium system, and demonstrated the capability of the system to supply and regulate the helium gas used to pressurize the LOX tank. The particular items involved in this test included the cold helium spheres, P/N 1A48858-1, S/N's 1138, 1145, 1165, 1170, 1174, and 1177; the plenum sphere, P/N 1A49991-1, S/N 46; the cold helium dump module, P/N 1B57781-503-003, S/N 21; the LOX tank pressurization control module, P/N 1B42290-503, S/N 31; and the associated plumbing, manifold assemblies, pressure switches, and transducers.

Initiated on 8 August 1967, the procedure was completed on 10 August 1967 after 3 days of activity, and was accepted on 13 September 1967. In general, the leak checks were conducted by pressurizing the system with helium gas and using a USON helium leak detector or LOX compatible leak detection bubble solution to locate any leakage. Gross leakage was located by listening for audible escaping gas.

The GSE and stage test setups were accomplished, and the cold helium system was isolated from other systems. The LOX tank pressure sensing line was pressurized to 50 ±5 psia and leak checked, and leak checks were conducted on the transducer for measurement D577 and on the LOX tank pressure switch.

The cold helium spheres were pressurized to 50 psig, the system was verified to have no gross leakage upstream or downstream of the pressurization control module, and the proper operation of the cold helium dump valve was verified. The LOX pressurization system downstream of the control module was then vented to ambient. The cold helium spheres were pressurized to 500 psia while a

4.2.20 (Continued)

check verified that the cold helium regulator discharge pressure did not increase as the spheres were pressurized. The cold helium spheres were then pressurized to 950 +0, -25 psia and held at this pressure for 3 minutes for a sphere integrity test.

Following the integrity test, the spheres were vented to 825 $\pm$25 psia and leak checks were conducted on the cold helium system upstream of the pressurization control module, from the cold helium dump module to the helium spheres manifold, and on the line to the transducer for measurement D16. The helium spheres were then vented to 500 psig through the cold helium dump valve while leak checks were conducted on the dump valve vent system. The seat leakages of the cold helium dump module dump and relief valve and the LOX tank pressurization control module shutoff valves were all verified to be less than the 12.5 scim each limits.

The cold helium spheres were vented to 400 $\pm$50 psia, and the cold helium shutoff valves were verified to operate properly. Leak checks were then conducted on the cold helium system downstream of the pressurization control module, including the transducer for measurement D105, the thermistor for measurement C230, the pressure switch, and the heat exchanger inlet and return lines. After the completion of these checks the cold helium system was vented to ambient and the stage was returned to the pre-test configuration.

Engineering comments noted that there were no parts shortages affecting this test. Several leaks were found during this test. The following leaks were corrected immediately without requiring FARR action:

a. In the aft thrust structure area, pipe assembly, P/N 1B64811-1, leaked at the B-nut at the cross to pipe assembly, P/N 1B52429-1; and pipe assembly, P/N 1B52403-1, leaked at the outlet flange on the LOX tank pressurization module.
b. In the auxiliary tunnel area, pipe assembly, P/N 1B67329-1, leaked at the B-nut to the manifold; the manifold, P/N 1A68668-511, leaked at the B-nut at the union to pipe assembly, P/N 1B52409-1; pipe assembly, P/N 1B52441-1, leaked at the B-nut at the union to pipe assembly, P/N 1B52409-1; and pipe assembly, P/N 1B52409-1, leaked at the B-nut at the union to pipe assembly, P/N 1B52441-1.

4.2.20 (Continued)

c. At location 403A74, pipe assembly, P/N 1B52405-1, leaked at the seal at the sphere flange.

Two other leaks were corrected by the following FARR's:

a. FARR A248698 rejected orifice fitting, P/N 1B63046-515, because scratches on the sealing surface caused leakage at the B-nut connection to pipe assembly, P/N 1B64137-1. A new orifice was installed, correcting the leakage.

b. FARR A261309 noted a gouge in the dual fitting seating surface of pipe assembly, P/N 1B58807-1, causing leakage. The seating surface was polished to the required finish, and the pipe assembly was accepted for use.

Three revisions were made to the procedure for the following:

a. One revision increased the cold helium sphere integrity pressure to be 950 +0, -25 psia rather than 750 psig; vented the spheres to 825 $\pm$25 psia rather than 700 psig after the integrity test; set the GSE supply pressure to 825 $\pm$25 psia; and pressurized the supply line to this pressure for the leak check. This was to comply with current design requirements and to ensure that the supply line was pressurized for the leak check.

b. Two revisions vented the helium spheres to 400 $\pm$50 psia rather than 250 psig for the low pressure leak checks; verified that a hand valve on pipe assembly, P/N 1B52832-1, was open; and added steps to individually remove the electrical connectors at the LOX tank pressurization module, and to perform flow checks on the module valves. This was to comply with current design requirements on the test pressure, and to assure the operation of both valves in the LOX tank pressurization module.

4.2.21 <u>Hydraulic System Fill, Flush, Bleed, and Fluid Samples (1B40973 D)</u>

This manual procedure ensured that the hydraulic system was correctly filled, flushed, bled, and maintained free of contaminants during hydraulic system operation. The hydraulic fluid pressure and temperature were checked for proper operational levels, the hydraulic system transducers were tested for proper operation, and engine clearance in the aft skirt was verified. The hydraulic system components involved in this test were the auxiliary

4.2.21 (Continued)

hydraulic pump, P/N 1A66241-509, S/N X454664; the engine driven hydraulic pump, P/N 1A66240-503, S/N X457803; the accumulator/reservoir assembly, P/N 1B29319 -519, S/N 30; the pitch hydraulic actuator, P/N 1A66248-507-012, S/N 65; and the yaw hydraulic actuator, P/N 1A66248-507-012, S/N 64.

The procedure was started on 9 August 1967, and was completed, except for the preshipment operations, by 11 August 1967. The procedure was then held open for use during subsequent stage testing. During the hydraulic system automatic checkout, H&CO 1B59485, the pitch hydraulic actuator, P/N 1A66248-507-012, S/N 66, was rejected for leakage (reference FARR A261324, paragraph 4.2.28) and actuator, S/N 65, was installed. Those parts of this procedure involving the pitch actuator were repeated between 28 and 31 August 1967. At the completion of stage testing, the preshipment preparations were accomplished on 14 September 1967, and the procedure was accepted on 19 September 1967 after a total of 7 days of activity.

Before the test was started, the GSE and stage preliminary setups were accomplished. The GSE Model DSV-4B-358 hydraulic pumping unit (HPU), P/N 1A67443-1, was flushed and checked for hydraulic fluid cleanliness, and connected to the stage hydraulic system by pressure and return hoses.

The hydraulic system air tank was pressurized to 450 ±50 psig, and a leak check of the auxiliary pump purge system verified that there was no leakage. An air tank pressure decay check was then started, to run concurrent with other checks of the procedure. The air tank pressure was measured as 400 psig at the start of the test. The pressure was then measured after 12 ±1/2 hours, and again after an additional 12 ±1/2 hours. Both measurements were also 400 psig, showing that there was no pressure loss over this period.

After the air tank was initially pressurized, the accumulator/reservoir was pressurized to 1800 ±50 psig with nitrogen gas. The HPU was used to circulate hydraulic fluid through the stage hydraulic system at 1000 ±100 psig to flush the accumulator/reservoir. After 30 minutes of circulation, hydraulic fluid was drained from the bleed valves on the reservoir, the accumulator inlet and outlet, the engine driven pump outlet, and the auxiliary pump inlet, and the

4.2.21 (Continued)

fluid air content was verified not to be excessive. The auxiliary hydraulic pump was turned on for 5 minutes to flush the auxiliary pump and to circulate hydraulic fluid while the hydraulic system components and fluid connections were checked to verify that there was no external leakage. The engine driven hydraulic pump was flushed during this period by manually rotating the pump quill shaft. Checks were then made of the accumulator/reservoir low pressure and high pressure relief valve functions, as shown in Test Data Table 4.2.21.1.

Following these checks, the hydraulic system pressure was adjusted to 3650 ±50 psig and the reservoir piston was cycled ten times by reducing and increasing the hydraulic system pressure. During the last cycle, the maximum full reservoir oil level was measured as 99.7 percent, and the maximum empty reservoir oil level was measured as -0.3 percent, both within the respective limits of 98 to 102 percent and -2 to +2 percent. Hydraulic fluid samples were obtained from the HPU return and pressure sample points. The cleanliness samples met the particle count requirements.

The accumulator precharge and high pressure relief valve checks were started by pressurizing the accumulator with nitrogen gas to the 2350 psig required for the ambient air temperature of 70°F. The HPU was then used to pressurize the hydraulic system to 1500 ±100 psig and then to 4400 psig maximum, while it was verified that the system had no leaks at either pressure. The system pressure was then adjusted to 3650 ±50 psig and the high pressure relief valve functions were checked, as shown in the Test Data Table. The hydraulic system pressure was then reduced to 1000 ±100 psig, the air tank pressure was verified to be 450 ±50 psig, and the auxiliary hydraulic pump was turned on for 5 minutes while the reservoir nitrogen gas pressure was verified to be about 3600 psig.

The pitch and yaw actuators were detached from the stage and mounted on the GSE Model DSV-4B-474 engine actuator support kit fixture, P/N 1B56669-1. The GSE Model DSV-4B-699 gimbal control unit, P/N 1B50915-1, was then set up and connected to the actuators. The hydraulic system was pressurized to 3650 ±100 psig, using the HPU, and the gimbal control unit was used to cycle the pitch and yaw actuators with ±50 milliampere control signals. After 15 minutes of cycling, hydraulic fluid samples were taken from the HPU return

4.2.21 (Continued)

and pressure sampling ports, and the pitch and yaw actuator bleed ports. The hydraulic fluid cleanliness samples met the particle count requirements. The gimbal control unit and the HPU were turned off after the samples were obtained.

For the hydraulic system air content test, the system was pressurized to 3650 ±50 psig, using the HPU. After 3 minutes, the HPU was turned off and the system pressure was allowed to decay to 180 psig. Sufficient hydraulic fluid was then drained from the system to reduce the system pressure to 80 psig. The amount of fluid drained was verified to be less than 30 milliliters, indicating that the hydraulic system was satisfactorily filled and bled.

The pitch and yaw actuators were removed from the engine actuator support kit fixture and re-attached to the stage, and preparations were made for a square pattern slew check. The HPU was used to pressurize the hydraulic system to 1000 ±50 psig for this check, and the gimbal control unit was used to slowly slew the engine in a square pattern to the extremes of the actuator travels while the complete engine installation was checked for clearance and freedom of motion. At the conclusion of this check the actuators were centered, the hydraulic system pressure was increased to 3650 ±100 psig, and the actuator centering was repeated. The gimbal control unit and the HPU were turned off, and the gimbal control unit was disconnected from the actuators.

To compensate for hydraulic fluid thermal expansion, the accumulator nitrogen gas pressure was verified to be correct for the ambient temperature, and the hydraulic system was pressurized to 3650 ±100 psig for 3 minutes. The oil temperature was measured as 89.8^{o}F, and the required amount of fluid, 225 milliliters for this temperature, was drained from the reservoir bleed valve.

For a check of the hydraulic system transducers, the hydraulic system functions were checked as shown in the Test Data Table, first with the hydraulic system unpressurized, and then with the hydraulic system pressurized by means of the auxiliary hydraulic pump. This completed the hydraulic system preparations for subsequent test procedures.

As noted, the pitch actuator was replaced during the hydraulic system automatic checkout. Before being installed, the new actuator was mounted on

4.2.21 (Continued)

the engine actuator support kit, and it was verified that the actuator connections had no leakage when the hydraulic system was pressurized to 1500 ±100 psig, or to 4400 psig maximum. The gimbal control unit was connected to the new pitch actuator, and the pitch actuator only was cycled as before. After 15 minutes, hydraulic fluid samples were taken from the four ports as before. The fluid samples again met the cleanliness particle count requirements. The hydraulic system air content test was repeated as before, and the pitch actuator was removed from the engine actuator support kit and installed on the stage. The engine alignment procedure, H&CO 1B39095, was then re-accomplished (paragraph 4.2.4). The gimbal control unit was connected to the yaw actuator, and the square pattern slew check was performed as before. After the gimbal control unit was disconnected from both actuators, the hydraulic fluid thermal expansion compensation operation was repeated, with the oil temperature measured as 82°F, and with 250 milliliters of fluid drained, as required for this temperature. Those hydraulic system functions shown in the Test Data Table were rechecked only with the system pressurized. This completed the necessary rechecks.

After the completion of all other stage tests involving the hydraulic system, the system was prepared for stage shipment by depressurizing the air tank and the accumulator nitrogen gas pressure, and removing all auxiliary test equipment from the system.

Engineering comments noted that there were no parts shortages affecting this test. The problems encountered during this procedure were covered by the following FARR's:

a. FARR A248699 noted that hose assembly, P/N 1B63006-1, S/N 07380H100061, was bent with less than the required 6 inch minimum bend radius at a location 3 inches from the downstream flared end. The hose assembly was removed and a new hose assembly was installed.

b. FARR A248700 rejected hose assembly, P/N 1B63071-1, S/N 07380H800030, for a kink 3 inches from the upstream flared end. The hose assembly was removed and a new hose assembly was installed.

c. FARR A261303 was written because the pitch hydraulic actuator, P/N 1A66248-507-012, S/N 65, had burrs on the forward edges of both halves of the mid-stroke lock, P/N 131-29985, with the inside of the

4.2.21 (Continued)

locking groove on piston assembly, P/N 130-42827-1, scored and marked by these burrs. The burrs were blended off, and the rework was acceptable after inspection showed no other damage.

Twelve revisions were made to the procedure for the following:

a. One revision changed the method of obtaining fluid samples from the HPU oil sample return port, to provide the proper sampling method.

b. Five revisions corrected minor typing errors throughout the procedure.

c. Two revisions changed the air tank pressure limits to be 450 ±50 psig rather than approximately 450 psig at one place and 475 ±25 psig at another place, to show the correct tolerance and to make the requirements agree.

d. One revision added a provision for making a deviation if the hydraulic system high pressure relief valve did not operate.

e. One revision modified the preshipment test equipment removal operation to show the proper sequence for closing the water supply and drain valves before disconnecting the HPU water supply and drain hoses.

f. One revision added the necessary steps to install the replacement hose assemblies, P/N's 1B63006-1 and 1B63071-1, and to leak check the hoses and connections after installation.

g. One revision provided instructions for installing and leak checking the replacement pitch hydraulic actuator, and for repeating those parts of the procedure required to test the new actuator.

4.2.21.1 Test Data Table, Hydraulic System Fill, Flush, Bleed, and Fluid Samples

Function	Measurement	Limits
Accumulator/Reservoir Relief Valve Checks		
Low Pressure Relief Valve		
Relief Pressure, Ground Return (psig)	260.0	275.0 ±25.0
Reseat Pressure, Ground Return (psig)	250.0	240.0 min.
Relief Pressure, Overboard (psig)	260.0	275.0 ±25.0
Reseat Pressure, Overboard (psig)	248.0	240.0 min.
High Pressure Relief Valve		
System Hydraulic Pressure (psig)	4300.0	4400.0 max.
Return Pressure (psig)	265.0	*
Differential Pressure (psia)	4035.0	3900.0 min.
Accumulator High Pressure Relief Valve Checks		
System Internal Leakage (gpm)	0.63	0.8 max.
Relief Valve Cracking Pressure (psig)	4225.0	*
Reservoir Pressure (psig)	260.0	*

*Limits Not Specified

4.2.21.1 (Continued)

Function	Measurement	Limits
Accumulator High Pressure Relief Valve Checks (Continued)		
Differential Cracking Pressure (psi)	3965.0	4100.0 max.
Relief Valve Reseating Pressure (psig)	4175.0	*
Reservoir Pressure (psig)	258.0	*
Differential Reseating Pressure (psi)	3917.0	3760.0 min.
Hydraulic System Unpressurized		
Aft 5v Excitation Module (vdc)	4.97	5.00 ±0.05
Hydraulic System Pressure (psig)	1376.0	1400.0 approx.
Hydraulic Pump Inlet Oil Temperature (°F)	85.5	approx. ambient
Reservoir Oil Pressure (psia)	72.4	55.0 min.
Accumulator GN_2 Pressure (psia)	2343.0	2350.0 approx.
Accumulator GN_2 Temperature (°F)	74.5	approx. ambient
Reservoir Oil Level (%)	91.1	85.0 min.
Reservoir Oil Temperature (°F)	89.4	approx. ambient
Hydraulic System Pressurized		
Aft 5v Excitation Module (vdc)	4.97	5.00 ±0.05
Hydraulic System Pressure (psig)	3570.0	3650.0 ±150.0
Hydraulic Pump Inlet Oil Temperature (°F)	97.6	approx. ambient
Reservoir Oil Pressure (psia)	168.5	180.0 ±20.0
Accumulator GN_2 Pressure (psia)	3587.0	Syst. Press ±100
Accumulator GN_2 Temperature (°F)	84.0	approx. ambient
Reservoir Oil Level (%)	36.0	25.0 min.
Reservoir Oil Temperature (°F)	91.7	approx. ambient
T/M Pitch Actuator Position (deg)	-0.005	0.0 ±0.236
T/M Yaw Actuator Position (deg)	-0.011	0.0 ±0.236
Pitch Actuator Retest		
Aft 5v Excitation Module (vdc)	4.98	5.00 ±0.05
Reservoir Oil Level (%)	37.7	25.0 min.
T/M Pitch Actuator Position (deg)	0.009	0.0 ±0.236
T/M Yaw Actuator Position (deg)	-0.009	0.0 ±0.236

*Limits Not Specified

4.2.22 Propellant Utilization System Calibration (1B59826 F)

This manual calibration procedure verified the operation of the propellant utilization system, and provided the necessary calibration prior to the automatic checkout of the system. For calibration purposes, the propellant utilization test set (PUT/S), P/N 1A68014-1, was used to provide varying capacitance inputs to the propellant utilization electronics assembly (PUEA), simulating the LOX and LH_2 mass probe outputs under varying propellant load conditions. The particular items involved in this test were static inverter-converter 411A92A7, P/N 1A66212-507, S/N 29; propellant utilization electronics assembly 411A92A6, P/N 1A59358-527, S/N 24; LOX mass probe, P/N 1A48430-509-011, S/N D8; and LH_2 mass probe, P/N 1A48431-505-009, S/N C1.

The calibration procedure was accomplished on 9 and 10 August 1967, and was accepted on 15 August 1967. Measurements and ratiometer settings made during the test are shown in Test Data Table 4.2.22.1.

At the start of the test, megohm resistance measurements were made on both the LH_2 and LOX mass probe elements through connector 411W11P1 at the PUEA, using a 500 vdc megohmeter. The PUT/S was then connected to the PUEA and the static inverter-converter, and stage power for these units was manually turned on. The static inverter-converter voltages and operating frequency were then measured.

The PUEA bridge calibrations were conducted next. Simulated empty conditions were established with the PUT/S, and the PUEA LH_2 and LOX bridge empty calibrations were accomplished by nulling the bridge tap voltages with the PUT/S ratiometer, at settings of 0.02007 for the LH_2 bridge and 0.02013 for the LOX bridge, and then nulling the bridge outputs by adjusting the PUEA R2 potentiometer for the LH_2 bridge and the PUEA R1 potentiometer for the LOX bridge. Simulated full conditions were then established with the PUT/S, using a C1 capacitor (LH_2) setting of 187 picofarads and a C2 capacitor (LOX) setting of 122 picofarads, and the ratiometer was set to 0.92350. To accomplish the PUEA LH_2 and LOX bridge full calibrations, the bridge outputs were nulled by adjusting the PUEA R4 potentiometer for the LH_2 bridge and the PUEA R3 potentiometer for the LOX bridge.

4.2.22 (Continued)

Data acquisition was verified by establishing simulated empty and full conditions with the PUT/S, and adjusting the PUT/S ratiometer to null the PUEA LH_2 and LOX bridge outputs. Bridge slew checks were conducted by establishing simulated 1/3 and 2/3 slew conditions with the PUT/S, and adjusting the PUT/S ratiometer to null the PUEA LH_2 and LOX bridge outputs for each condition.

For the reference mixture ratio (RMR) calibration, the difference between the previously determined LOX and LH_2 empty ratiometer settings, 0.00002, was multiplied by 98.4 vdc to give a reference voltage of 0.001968 vdc. Simulated empty conditions were established with the PUT/S, and the PUEA residual empty bias R6 potentiometer was adjusted to null the RMR bias voltage. Simulated full conditions were then establsihed with the PUT/S, and PUEA residual full bias R5 potentiometer was adjusted to null the RMR bias voltage.

PUEA LH_2 and LOX bridge linearity checks were accomplished by individually setting the PUT/S C1 capacitor (LH_2) and C2 capacitor (LOX) to specific values, and adjusting the PUT/S ratiometer to null the appropriate PUEA bridge output.

For a check of the hardwire loading circuits, simulated full conditions were established with the PUT/S, the PUT/S ratiometer was set to 0.00000, and the hardwire loading circuit PUEA LH_2 and LOX bridge output voltages were measured. Both voltages were 26.02 vdc, meeting the 25.85 $\pm$2.0 vdc requirements. This completed the propellant utilization system calibration, and the stage power was turned off. It was noted that during this procedure approximately 9 cycles each were accumulated on the PUEA R1 (LOX) and R2 (LH_2) potentiometers.

Engineering comments noted that there were no parts shortages affecting this test. FARR A248695 was written during this procedure to reject static inverter-converter, P/N 1A66212-507, S/N 18. This unit had a V/P excitation voltage of 51.1 vdc, a 117 vdc output of 122.59 vdc, and an operating frequency of 406.6 Hz. These functions should have been 48.0 to 51.0 vdc, 115.0 to 122.5 vdc, and 400.0 $\pm$6.0 Hz, respectively. The defective unit was removed, and static inverter-converter, S/N 29, was installed and satisfactorily tested.

4.2.22 (Continued)

Two revisions were made to the procedure for the following:

a. One revision added a megohmeter, General Radio 1862C or equivalent, and an ac voltmeter, Hewlett Packard 400H or equivalent, to the Non-End Item Equipment list, for use during this test.

b. One revision added instructions for using a Fluke Model 825A voltmeter to measure the static inverter-converter voltages, as the precision dc voltmeter within the PUT/S was out-of-service for a faulty switch. The equivalent Fluke voltmeter was used until the PUT/S voltmeter was repaired.

4.2.22.1 Test Data Table, Propellant Utilization System Calibration

LH_2 Mass Probe Megohm Check, Plug 411W11P1

Function	Resistance (Megohms)	Limits (Megohms)
LH_2 Probe Elements, Pins G to E	500,000	1,000 min.
Pin G to Shield	80,000	*
Pin G to Vehicle Ground	56,000	*
Pin G Shield to Vehicle Ground	12,000	*
Pin E to Vehicle Ground	8,000	*

LOX Mass Probe Megohm Check, Plug 411W11P1

Function	Resistance (Megohms)	Limits (Megohms)
LOX Probe Elements, Pins A to C	290,000	1,000 min.
Pin C to Shield	240,000	*
Pin C to Vehicle Ground	4,000	*
Pin A to Vehicle Ground	2,500	*

Static Inverter-Converter Measurements

Function	Measurements	Limits
5.0 vdc Output Voltage (vdc)	4.927	4.50 to 5.10
21.0 vdc Output Voltage (vdc)	21.738	20.0 to 22.5
28.0 vdc Output Voltage (vdc)	27.97	26.0 to 30.0
V/P Excitation Voltage (vdc)	50.65	48.0 to 51.0
115 vrms Monitor Voltage (vdc)	2.72	2.28 to 3.18
117 vdc Output Voltage (vdc)	121.41	115.0 to 122.5
Test Point 2 Voltage (vdc)	21.76	20.0 to 22.5
Operating Frequency (Hz)	399.6	394.0 to 406.0

*Limits Not Specified

4.2.22.1 (Continued)

Data Acquisition

Function	PUT/S Ratiometer	Limits
LH_2 Empty	0.00039	0.00000 to 0.00185
LOX Empty	0.00041	0.00000 to 0.00185
LH_2 Full	0.92355	0.92165 to 0.92535
LOX Full	0.92340	0.92165 to 0.92535

Bridge Slew Checks

Function	PUT/S Ratiometer	Limits
LH_2 1/3 Slew	0.32519	0.30000 to 0.36000
LH_2 2/3 Slew	0.63257	0.60000 to 0.68000
LOX 1/3 Slew	0.30793	0.30000 to 0.36000
LOX 2/3 Slew	0.63540	0.60000 to 0.68000

LH_2 Bridge Linearity Check

PUT/S C1 Value	PUT/S Ratiometer	Limits
50 pf	0.24685	0.24508 to 0.24878
100 pf	0.49269	0.49200 to 0.49570
150 pf	0.73955	0.73893 to 0.74263
187 pf	0.92355	0.92165 to 0.92535

LOX Bridge Linearity Check

PUT/S C2 Value	PUT/S Ratiometer	Limits
20 pf	0.15075	0.14954 to 0.15324
50 pf	0.37730	0.37663 to 0.38033
70 pf	0.52836	0.52700 to 0.53173
100 pf	0.75548	0.75512 to 0.75882
122 pf	0.92350	0.92165 to 0.92535

4.2.23 Propellant Tanks System Leak Check (1B59432 B)

This manual leak check procedure verified the integrity of the stage propellant tanks and associated plumbing, the vacuum jacketed LH_2 feed and chilldown supply ducts, and the common bulkhead vacuum monitoring system. The particular items involved in this test, and the appropriate measured values, are shown in Test Data Table 4.2.23.1.

Initiated on 9 August 1967, the procedure was completed on 21 August 1967 after 4 days of activity, and was accepted on 8 September 1967. The leak checks were generally accomplished by pressurizing the system with helium gas and using a

4.2.23 (Continued)

USON helium leak detector or LOX compatible leak detection bubble fluid to locate any leakage. Gross leakage was located by listening for audible escaping gas.

A vacuum check of the LH_2 vacuum jacketed ducts was accomplished first. For each duct tested, a thermocouple vacuum gauge meter, P/N 1A94433-501, S/N 4, was connected to the vacuum sensing thermoprobe built into the duct, and the vacuum indication was measured. The common bulkhead vacuum monitoring system was leak checked next. The system was pressurized to about 3 psig, and it was verified that there were no obstructions in the monitoring system fittings by temporarily cracking the B-nut at the transducer for measurement D237 and using leak detection bubble fluid to verify that gas was flowing properly. Leak checks were then conducted on all connections of the system from the aft umbilical disconnect to the common bulkhead and the transducer for measurement D545, and from the common bulkhead to the transducer for measurement D237. The system was vented to ambient at the conclusion of these checks.

A special check verified the proper operation of the LH_2 chilldown flowmeter. With the chilldown shutoff valves temporarily closed, the directional control valve in the ground position, and the LH_2 tank vent valve open, helium was flowed through the temperature transducer port on the LH_2 chilldown shutoff valve housing while the flowmeter output was monitored to verify the proper spin of the LH_2 chilldown flowmeter.

The stage and GSE were prepared for the propellant tanks pressurization, and the repressurization helium spheres were pressurized to 700 $\pm$100 psia. The LOX tank was incrementally pressurized to 2.5 psig while it was verified that there was no gross leakage. A flowmeter was used to measure the seal leakages of the LOX tank valves and components, and leak checks were conducted on all connections of the LOX tank pipe and duct assemblies.

The LH_2 tank was then incrementally pressurized to 2.5 psig while it was verified that there was no gross leakage. A flowmeter was used to measure the seal leakages of the LH_2 tank valves, and leak checks were conducted on all connections of

4.2.23 (Continued)

the LH_2 tank pipe and duct assemblies, on the static seals of the LH_2 relief and vent valves, and on the LH_2 tank cover plate. At the completion of these checks the LH_2 and LOX tanks, and the helium spheres, were all vented to ambient pressure, and the stage was returned to the pre-test condition.

Engineering comments noted that there were no parts shortages affecting this test. Two leaks were discovered and corrected during the test, no other problems were encountered, and no FARR's were written. The leaks were:

a. At the outlet B-nut of pipe assembly, P/N 1B64115-1, in the forward dome sense line. The fitting and seal were replaced to correct the leak.

b. At the LH_2 tank cover plate, P/N 1B63184-1, on the top of the forward dome. The seal was replaced to correct the leak.

Eight revisions were made to the procedure:

a. One revision changed the setup, checkout, and post test instructions for the common bulkhead vacuum monitoring system leak check, to utilize existing facilities.

b. One revision changed a propellant tank prepressurization setup step to verify that a hand valve on the LH_2 dome was closed, rather than to open the hand valve, in order to maintain the LH_2 tank pressure.

c. One revision deleted the leak check of the balance line between the LOX tank vent tee and relief valve, as this pipe assembly was no longer installed.

d. One revision added maximum allowable blade shaft seat leakage limits of 100 sccm each for the LOX and LH_2 fill and drain valves.

e. Three revisions added the chilldown flowmeter spin verification test. The necessary steps for the test setups, a LOX chilldown flowmeter test, and an LH_2 chilldown flowmeter test were added. The LOX chilldown flowmeter test was then deleted, as the flowmeter spin method was adequately verified on the LH_2 system. A final step was also added to close the LH_2 tank vent valve after the LH_2 chilldown flowmeter test, to correct a procedure omission.

f. One revision added a provision to measure the pilot valve cap seal leakage on the LH_2 vent valve if any leakage was evident during the leak check. A maximum allowable combined external leakage of 300 scim was specified for this measurement.

4.2.23.1 Test Data Table, Propellant Tanks System Leak Check

Vacuum Duct Checks

Name	P/N	S/N	Vacuum (microns of Hg.) Meas.	Limit
Engine LH_2 Feed Duct	1A49320-501	36	15	250 max
Engine LH_2 Feed Duct	1A49320-511	37R	19	250 max
LH_2 Chilldown Supply Duct	1A49966-503	25	50	250 max

Seal Leakage Tests

Component	P/N	S/N	Leakage Measurement	
LOX Fill and Drain Valve	1A48240-505	43	Main Seal:	0 sccm
			Blade Shaft Seal:	0 sccm
LOX Prevalve	1A49968-509	143	Shaft Seal:	0 sccm
LOX Chilldown Pump	1A49423-505	1836	Cavity Seal:	19 scim
LH_2 Fill and Drain Valve	1A48240-505	54	Main Seal:	3.15 sccm
			Blade Shaft Seal:	0 sccm
LH_2 Vent Valve and	1A48257-509	42	Combined	
LH_2 Relief Valve	1A49591-527	109	Main Seal:	2.9 sccm
LH_2 Vent Valve	1A48257-509	42	Comb. Open/ Close Piston Seals:	0 sccm
			Closing Piston Seals:	0.58 sccm
LH_2 Directional Control Valve	1A49988-501	29	Shaft Seal:	0 sccm
LH_2 Prevalve	1A49968-507	122	Shaft Seal:	0 sccm

4.2.24 Propellant Utilization System (1B59481 E)

This automatic checkout procedure verified the ability of the propellant utilization system to determine and control the engine propellant flow mixture ratio to ensure simultaneous propellant depletion, and to provide propellant level information to control the fill and topping valves during LOX and LH_2 loading. This test involved all components of the stage propulsion utilization system, including the propellant utilization valve in the J-2 engine, and the following:

Part	Ref. Location	P/N	S/N
Propellant Utilization Electronics Assembly (PUEA)	411A92A6	1A59358-527	24
Static Inverter-Converter	411A92A7	1A66212-507	29
LOX Mass Probe	406A1	1A48430-509-011	D8
LH_2 Mass Probe	408A1	1A48431-505-009	C1
LOX Overfill Sensor	(Part of LOX Mass Probe)		
LOX Overfill Control Unit	404A72A4	1A68710-511	C13
LOX Fast Fill Sensor	406A2C5	1A68710-1	D111
LOX Fast Fill Control Unit	404A72A5	1A68710-511	C44
LH_2 Overfill Sensor	(Part of LH_2 Mass Probe)		
LH_2 Overfill Control Unit	411A92A24	1A68710-509	C9
LH_2 Fast Fill Sensor	408A2C5	1A68710-1	F37
LH_2 Fast Fill Control Unit	411A92A43	1A68710-509	C5

This procedure was accomplished by the first attempt on 10 August 1967, and was accepted on 22 August 1967. The measurement values presented in this narration and in Test Data Table 4.2.24.1 are from this attempt. Most measurements were made through the AO and BO telemetry multiplexers, as indicated in the Table.

After initial conditions were established, ratio values were obtained from the manual Propellant Utilization System Calibration procedure, H&CO 1B59826, and loaded into the computer. From these ratio values, nominal test values were computed for LOX and LH_2 coarse mass voltages, fine mass voltages, and loading voltages. The propellant utilization (PU) system power test was conducted first. Power was applied to the PU inverter and electronics, then the forward bus 2 voltage, the static inverter-converter output voltages and operating frequency, and the PU system internal temperature, were all measured.

The servo bridge balance and ratio valve null test was conducted next. The error signal voltage, the ratio valve position voltage, and the LOX and LH_2 coarse and fine mass voltages were all measured.

4.2.24 (Continued)

The PU loading test followed. The GSE loading potentiometer power was turned on, and the voltage measured. Measurements were then made of the LOX and LH_2 loading potentiometer sense voltages and signal voltages. Measurements of the LOX and LH_2 loading potentiometer signal voltages were repeated after the LOX and LH_2 bridge 1/3 checkout relay commands were turned on, and again after these commands were turned off. The GSE power was turned off, and the LOX and LH_2 loading potentiometer sense voltages were again measured.

The servo balance bridge gain test was conducted next. The error signal voltage, the ratio valve position voltage, and the LOX and LH_2 coarse and fine mass voltages were measured. The ratio valve position voltage and the mass voltages were remeasured with the LOX and LH_2 1/3 checkout relays on, with the bridge 2/3 checkout relays on, with the 2/3 checkout relays off, and again with the 1/3 checkout relays off. The error signal voltage was also remeasured during this last check.

The next check verified that the LOX and LH_2 tank overfill and fast fill sensors, and their associated control units, responded properly under ambient (dry) conditions and under simulated sensor wet conditions.

The PU valve movement test measured the change in the ratio valve position voltage indication during a 50 second plus valve slew and a 50 second minus valve slew. The ratio valve position voltage indication and the system test valve position signal (test error signal) were measured before the start of each slew.

The last part of this procedure was the PU activate test. The ratio valve position voltage was measured, then the LOX bridge 1/3 checkout relay command was turned on and the LOX coarse mass voltage was measured. The ratio valve position voltage was remeasured with the PU activate switch turned on, and again with it turned off. The LOX bridge 1/3 checkout relay command was turned off, and the LOX coarse mass voltage and the ratio valve position voltage were remeasured. These steps were then repeated using the LH_2 bridge 1/3 checkout relay, and with the LH_2 coarse mass voltage measured.

4.2.24 (Continued)

This completed the propellant utilization system test. It was noted that the PU inverter and electronics power was on for an accumulated time of 39 minutes 27.632 seconds, that the switch selector was used 6 times, and that the LOX and LH_2 bridge potentiometers were each cycled 3 times.

Engineering comments noted that there were no parts shortages affecting this test. No major problems were encountered during the test, and no FARR's were written. One minor problem occurred during the PU valve movement test. Before the plus valve slew check, the test valve position signal was measured as 1.04 vdc, outside of the acceptable 1.00 $\pm$0.02 vdc limits. After an additional 1 second delay, the signal was remeasured as an acceptable 0.994 vdc.

Two revisions were made to the procedure:

a. One revision added steps to manually verify that the low RACS check was operative for the propellant utilization system oven on indication, measurement K151.

b. One revision deleted the hydraulic reservoir oil level low indication from the stage power setup, initial conditions scan, and safety item monitor interrupt functions, as the hydraulic system fill, flush, and bleed procedure, H&CO 1B40973, was active at the time this test was conducted, and the low oil level indication was invalid and irrelevant.

4.2.24.1 Test Data Table, Propellant Utilization System

Loaded Values (from H&CO 1B59826)

LOX Empty Ratio	0.000	LH_2 Empty Ratio	0.000
LOX Wiper Ratio	0.020	LH_2 Wiper Ratio	0.020
LOX 1/3 Bridge Slew Ratio	0.308	LH_2 1/3 Bridge Slew Ratio	0.325
LOX 2/3 Bridge Slew Ratio	0.635	LH_2 2/3 Bridge Slew Ratio	0.635

Residual Bias Empty Voltage 0.002 vdc

Computed Coarse Mass Voltages (vdc)

LOX Empty	0.000	LH_2 Empty	0.000
LOX 1/3 Mass	1.538	LH_2 1/3 Mass	1.626
LOX 2/3 Mass	3.174	LH_2 2/3 Mass	3.174

4.2.24.1 (Continued)

Computed Fine Mass Voltages (vdc)

LOX Empty	1.953	LH_2 Empty	1.953
LOX 1/3 Mass	2.144	LH_2 1/3 Mass	3.867
LOX 2/3 Mass	4.204	LH_2 2/3 Mass	4.204

Computed Loading Voltages (vdc)

LOX Empty	0.000	LH_2 Empty	0.000
LOX 1/3 Coarse Mass	8.613	LH_2 1/3 Coarse Mass	9.105

PU System Power Test

Function	Measurement	Limits
Forward Bus 2 Voltage (vdc)	28.72	28.0 ±2.0
Inv.-Conv. 115 vrms Output (vrms)	114.598	115.0 ±3.4
Inv.-Conv. 21 vdc Output (vdc)	21.913	21.25 ±1.25
Inv.-Conv. 5 vdc Output (vdc)	4.979	4.8 ±0.3
Inv.-Conv. Operating Frequency (Hz)	400.375	400.0 ±6.0
PU System Internal Temperature (°F)	87.293	75.0 ±35.0

Bridge Balance and Ratio Valve Null Test

Function	Meas. (vdc)	AO (vdc)	BO (vdc)	Limits (vdc)
Error Signal Voltage	0.690	-	-	0.002 ±1.0
Ratio Valve Position Voltage		2.630	-	2.65 ±0.12
LOX Coarse Mass Voltage		0.015	0.015	0.000 ±0.1
LOX Fine Mass Voltage		2.080	2.075	1.953 ±0.4
LH_2 Coarse Mass Voltage		0.024	0.020	0.000 ±0.1
LH_2 Fine Mass Voltage		2.104	2.109	1.953 ±0.4

PU Loading Test

Function	Measurement (vdc)	Limits (vdc)
GSE Power Supply Voltage	28.958	28.0 ±2.0

Loading Potentiometer Function	LOX Pot. (vdc)	LH_2 Pot. (vdc)	Limits (vdc)
Sense Voltage, GSE Power On	28.919	28.879	GSE Pwr ±0.4
Signal Voltage, Relays Off	0.027	0.000	Load Volt ±0.5
Signal Voltage, Relays On	8.340	8.969	Load Volt ±2.0
Signal Voltage, Relays Off	0.055	0.000	Load Volt ±0.5
Sense Voltage, GSE Power Off	0.000	0.039	0.0 ±0.75

4.2.24.1 (Continued)

Servo Balance Bridge Gain Test

Function	Meas. (vdc)	AO (vdc)	BO (vdc)	Limits (vdc)
Error Signal Voltage	0.703	-	-	0.002 $\pm$1.0
Ratio Valve Position Voltage		2.630	-	2.630 $\pm$0.12
LOX Coarse Mass Voltage		0.020	0.015	0.000 $\pm$0.1
LOX Fine Mass Voltage		2.061	2.056	1.953 $\pm$0.4
LH_2 Coarse Mass Voltage		0.010	0.015	0.000 $\pm$0.1
LH_2 Fine Mass Voltage		2.080	2.080	1.953 $\pm$0.4
-1/3 Checkout Relays On-				
Ratio Valve Position Voltage		2.589	-	2.630 $\pm$0.12
LOX Course Mass Voltage		1.548	1.548	1.538 $\pm$0.1
LOX Fine Mass Voltage		2.314	2.305	2.144 $\pm$0.4
LH_2 Coarse Mass Voltage		1.636	1.636	1.626 $\pm$0.1
LH_2 Fine Mass Voltage		4.028	4.038	3.867 $\pm$0.4
-2/3 Checkout Relays On-				
Ratio Valve Position Voltage		2.548	-	2.630 $\pm$0.12
LOX Coarse Mass Voltage		3.188	3.198	3.174 $\pm$0.1
LOX Fine Mass Voltage		4.561	4.556	4.204 $\pm$0.4
LH_2 Coarse Mass Voltage		3.184	3.193	3.174 $\pm$0.1
LH_2 Fine Mass Voltage		4.556	4.551	4.204 $\pm$0.4
-2/3 Checkout Relays Off-				
Ratio Valve Position Voltage		2.584	-	2.630 $\pm$0.12
LOX Coarse Mass Voltage		1.548	1.548	1.538 $\pm$0.1
LOX Fine Mass Voltage		2.300	2.300	2.144 $\pm$0.4
LH_2 Coarse Mass Voltage		1.641	1.636	1.626 $\pm$0.1
LH_2 Fine Mass Voltage		4.004	4.019	3.867 $\pm$0.4
-1/3 Checkout Relays Off-				
Error Signal Voltage	0.563	-	-	0.002 $\pm$1.0
Ratio Valve Position Voltage		2.625	-	2.630 $\pm$0.12
LOX Coarse Mass Voltage		0.015	0.015	0.000 $\pm$0.1
LOX Fine Mass Voltage		2.041	2.041	1.953 $\pm$0.4
LH_2 Coarse Mass Voltage		0.005	0.010	0.000 $\pm$0.1
LH_2 Fine Mass Voltage		2.051	2.051	1.953 $\pm$0.4

PU Valve Movement Test

Function	Meas. (vdc)	AO (vdc)	BO (vdc)	Limits (vdc)
-50 Second Plus Valve Slew-				
Ratio Valve Position Voltage		2.636	2.630	2.630 $\pm$0.12
Test Valve Position Signal	0.994	-	-	1.00 $\pm$0.02
Voltage Change at T +3 Seconds		-0.313	-	-0.154 to -0.480

4.2.24.1 (Continued)

Function	Meas. (vdc)	AO (vdc)	BO (vdc)	Limits (vdc)
Voltage Change at T+5 Seconds		-0.396	-	-0.201 to -0.559
Voltage Change at T+8 Seconds		-0.446	-	-0.225 to -0.559
Voltage Change at T+20 Seconds		-0.457	-	-0.395 to -0.559
Voltage Change at T+50 Seconds		-0.457	-	-0.395 to -0.559

-50 Second Minus Valve Slew-

Ratio Valve Position Voltage		2.63	-	2.630 ±0.12
Test Valve Position Signal	-0.994	-	-	-1.00 ±0.02
Voltage Change at T+3 Seconds		0.298	-	0.154 to 0.480
Voltage Change at T+5 Seconds		0.374	-	0.201 to 0.559
Voltage Change at T+8 Seconds		0.415	-	0.225 to 0.559
Voltage Change at T+20 Seconds		0.436	-	0.395 to 0.559
Voltage Change at T+50 Seconds		0.436	-	0.395 to 0.559

PU Activate Test

Function	AO (vdc)	BO (vdc)	Limits (vdc)
Ratio Valve Position Voltage	2.641	2.630	2.630 ±0.12
LOX Coarse Mass Voltage, Relay On	1.543	1.548	1.538 ±0.1
Ratio Valve Position Voltage, PU On	0.128	0.123	1.0 max.
Ratio Valve Position Voltage, PU Off	2.595	2.600	1.5 min.
LOX Coarse Mass Voltage, Relay Off	0.015	0.010	0.000 ±0.1
Ratio Valve Position Voltage	2.630	2.630	2.630 ±0.12
LH_2 Coarse Mass Voltage, Relay On	1.636	1.631	1.626 ±0.1
Ratio Valve Position Voltage, PU On	4.656	4.656	4.0 min.
Ratio Valve Position Voltage, PU Off	2.63	2.63	3.5 max.
LH_2 Coarse Mass Voltage, Relay Off	0.010	0.015	0.000 ±0.1
Ratio Valve Position Voltage	2.625	2.625	2.630 ±0.12

4.2.25 Exploding Bridgewire System (1B59597 E)

This automatic procedure verified the integrity of the exploding bridgewire (EBW) system, and demonstrated the capability of the EBW system to initiate ullage rocket ignition and jettison when commanded by the instrument unit during flight. The particular items involved in this test were:

Part Name	Ref. Location	P/N	S/N
Ullage Rocket Ignition System			
EBW Firing Unit	416A1	40M39515-119	539
EBW Firing Unit	416A2	40M39515-119	533
Pulse Sensor	416A7A1	40M02852	542
Pulse Sensor	416A7A2	40M02852	598
EBW Firing Unit	417A1	40M39515-119	535
EBW Firing Unit	417A2	40M39515-119	537
Pulse Sensor	417A7A1	40M02852	591
Pulse Sensor	417A7A2	40M02852	570
EBW Firing Unit	418A1	40M39515-119	536
EBW Firing Unit	418A2	40M39515-119	538
Pulse Sensor	418A7A1	40M02852	569
Pulse Sensor	418A7A2	40M02852	462
Ullage Rocket Jettison System			
EBW Firing Unit	404A75A1	40M39515-113	273
EBW Firing Unit	404A75A2	40M39515-113	268
Pulse Sensor *	404A75A10A1	40M02852	600
Pulse Sensor *	404A75A10A2	40M02852	99
* on Pulse Sensor Bracket Assembly	404A75A10	1A97791-501	15

This procedure was accomplished on 11 August 1967, and was accepted on the same date. Throughout this procedure, the charged condition of each EBW firing unit was determined by verifying that the firing unit voltage indication measured 4.2 $\pm$0.3 vdc, while the uncharged or discharged condition was determined by verifying that the voltage indication measured 0.0 $\pm$0.3 vdc or, during the firing unit disable test only, 0.2 $\pm$0.3 vdc.

The stage power setup, H&CO 1B59590, was accomplished, and initial conditions were established. An EBW pulse sensor self test was conducted first, by verifying that the self test command properly turned on the eight EBW pulse sensors, and that the reset command properly turned off the pulse sensors.

4.2.25 (Continued)

The ullage ignition EBW firing units were tested next. The charge ullage ignition command was verified to properly charge the six ullage ignition EBW firing units while both ullage jettison EBW firing units remained uncharged. To verify that the fire ullage ignition command properly fired the ullage ignition EBW firing units, it was determined that the six ignition pulse sensors were turned on while both jettison pulse sensors remained off, and that the six ullage ignition EBW firing units were discharged.

The ullage jettison EBW firing units were tested in the same way, by verifying that the charge ullage jettison command charged only the ullage jettison EBW firing units, and that the fire ullage jettison command fired only the jettison firing units and turned on only the jettison pulse sensors.

A series of checks then verified that the EBW ullage rocket firing unit disable command prevented the firing units from charging when the charge ullage ignition and charge ullage jettison commands were turned on, and discharged the firing units while preventing them from firing when the fire ullage ignition and fire ullage jettison commands were turned on.

A final series of checks verified the operation of the EBW pilot relay by determining that the pilot relay reset indication was off after each of the charge ullage ignition and jettison and fire ullage ignition and jettison commands were turned on, and that the pilot relay reset indication was on after each command was reset. This completed the exploding bridgewire system test. The switch selector was used 22 times during this test, and each of the ignition and jettison firing units was discharged 3 times.

Engineering comments noted that there were no parts shortages affecting this test. No problems were encountered during the test, no FARR's were written, and no revisions were made to the procedure.

4.2.26 Auxiliary Propulsion System (1B59601 E)

The auxiliary propulsion system test procedure verified the integrity of the stage wiring associated with APS functions, and verified receipt of command signals routed from the GSE automatic checkout system, through the attitude control relay packages, to the APS electrical interfaces. The Model DSV-4B-188 APS simulators, used in place of the uninstalled flight APS modules for this test, did not simulate the APS modules functionally, but provided suitable loads at the electrical interface to determine that the stage mounted components of the APS functioned properly.

All stage mounted components of the APS were tested, in particular the attitude control relay packages, P/N 1B57731-1, S/N 340, at reference location 404A75A4, and S/N 354, at reference location 404A71A19.

This automatic procedure was satisfactorily accomplished by the first attempt on 11 August 1967, and was accepted on 21 August 1967. The data in this narration and in Test Data Table 4.2.26.1 are from this attempt.

After initial conditions were established the GSE IU substitute -28 vdc power supply was turned on and measured at -30.04 vdc, within the -29 $\pm$2 vdc revised limits. The APS firing enable command and the APS bus power were turned on. A series of tests were then conducted to verify the proper operation of the APS engine valve solenoids. The attitude control nozzle commands were turned on and the appropriate APS engine valve open indication voltage was measured through the AO and BO instrumentation multiplexers.

The attitude control nozzle command was then turned off and the valve open indication voltage was again measured. At the conclusion of these tests the stage was returned to the pretest configuration, thereby completing the test procedure.

Engineering comments noted that there were no parts shortages affecting this test. The only problem encountered during the test was that the instrument unit substitute -28 vdc power supply voltage was -30.04 vdc, exceeding the -28 $\pm$2 vdc limits. This measurement was acceptable after a procedure revision

4.2.26 (Continued)

changed the limits, as noted below. No FARR's were written during the test. Two revisions were made to the procedure:

a. One revision changed the Running Time/Cycle Record paragraph to note that the relay control packages, P/N 50M35076-1, (Douglas P/N 1B57731-1), each contained three event meters, and that information was to be taken from these meters at the conclusion of the test. This was to conform to test requirements drawing 1B64707.

b. One revision changed the instrument unit substitute -28 vdc power supply voltage limits to be -29 ±2 vdc rather than -28 ±2 vdc, to agree with the power supply specifications.

4.2.26.1 Test Data Table, Auxiliary Propulsion System

Attitude Control Nozzle Command		APS Engine	Valve Open Indication Voltage (vdc) AO Multi.	BO Multi.	Limits
Nozzle I IV	On	1-1 or 1-3	4.24	4.24	4.2 ±0.30
	Off	1-1 or 1-3	0.00	0.00	0.0 ±0.25
Nozzle I II	On	1-1 or 1-3	4.18	4.19	4.2 ±0.30
	Off	1-1 or 1-3	0.01	0.00	0.0 ±0.25
Nozzle I P	On	1-2	4.19	4.19	4.2 ±0.30
	Off	1-2	0.00	0.00	0.0 ±0.25
Nozzle III II	On	2-1 or 2-3	4.13	4.13	4.0 ±0.30
	Off	2-1 or 2-3	0.01	0.00	0.0 ±0.25
Nozzle III IV	On	2-1 or 2-3	4.11	4.11	4.0 ±0.30
	Off	2-1 or 2-3	0.00	0.00	0.0 ±0.25
Nozzle III P	On	2-2	4.15	4.15	4.0 ±0.30
	Off	2-2	0.00	0.00	0.0 ±0.25

4.2.27 J-2 Engine System Leak Check (1B59433 C)

The manual leak check of the J-2 engine system was subdivided into two separate procedures. The J-2 engine leak check began with the pressurization, leak check, and depressurization of the start sphere. This was followed by a pressurization and leak check of the control sphere, and leak checks of the pneumatic lines with the mainstage control, helium control, ignition phase control, and start tank discharge control solenoids energized and de-energized. The thrust chamber leak check involved pressurization of the chamber, and leak

4.2.27 (Continued)

checks of the system, under pressure, downstream of the main fuel and oxidizer valves, and the engine portion of the LH_2 tank pressurization system.

Initiated on 11 August 1967, the procedure was completed on 22 August 1967 after 7 days of activity. Parts of the procedure were used on 8 September 1967 to leak check transducers replaced during the DDAS checkout, H&CO 1B59594, as noted in paragraph 4.2.18. The procedure was accepted 13 September 1967. Helium gas was used for pressurization during this procedure, and leakage was detected by the use of a USON leak detector, leak detection fluid, or, for engine connections having leak detection ports, a Rocketdyne G3104 pneumatic flow tester. Gross leakage was detected by listening for audible escaping gas.

The test configuration was established for the engine leak check, and the stage pneumatic control sphere was pressurized to 245 +10, -20 psig. The start tank was pressurized to about 100 psia, the proper operation of the start tank vent valve was verified, and the start tank vent line was leak checked. The start tank was then pressurized to 650 ±25 psia for an integrity test, with checks made at 200 and 400 psia to verify that there was no gross leakage. The integrity pressure was held for 3 minutes, then the start tank was vented to 600 ±25 psia, the start tank fill line was leak checked, and the start tank was vented to ambient pressure.

The engine control sphere was pressurized to about 100 psia, and the proper operation of the control sphere vent valve was verified. The control sphere was then pressurized to 1750 ±50 psia for an integrity test, with checks made at each 500 psi increment to verify that there was no gross leakage. The integrity pressure was held for 3 minutes, then the sphere was vented to 1500 ±50 psia and leak checks were conducted on the control sphere fill and outlet lines. The engine control sphere was then vented to between 225 and 250 psig for the remaining system leak checks. During these leak checks, the mainstage control, helium control, ignition phase control, and start tank discharge control solenoids were energized and de-energized as required to supply pressure to the various system lines, and all pressurized lines, connections, and valve

4.2.27 (Continued)

check ports were leak checked. At the conclusion of these checks, the engine control sphere and the ambient helium sphere were vented to ambient pressure, and all of the control solenoids were de-engerized.

The test configuration was then established for the thrust chamber leak check, and the thrust chamber was pressurized to about 30 psig. It was verified that there were no gross leakages, and leak checks were conducted on the thrust chamber purge and childown lines, and on all of the system lines and connections that were pressurized. The thrust chamber was then vented to ambient pressure to complete the procedure.

Engineering comments noted that there were no parts shortages affecting this test. Six leaks were found during this procedure; two were corrected without FARR action, and one FARR was written to correct the other four.

a. On the start tank fill line, pipe assembly, P/N 1B52566-1, leaked at the inlet B-nut at the thrust structure stringer 5 customer disconnect. A new elbow was installed to correct this leak.

b. Pipe assembly, P/N 558270, between the oxidizer turbine bypass valve close port and the main oxidizer valve standby port, leaked at the weld. The pipe assembly was rewelded to an acceptable condition.

c. FARR A261313 noted four leaks. Pipe assembly, P/N 558268, between the ignition phase control solenoid closed line and the main fuel valve open and standby ports, leaked at the sleeve weld; pipe assembly, P/N 558269, between the main fuel valve and the start tank discharge solenoid, leaked at the weld; and solenoid valve assembly, P/N 557998, S/N 4089018, leaked at the bottom plug on the valve seal, and at the flange to the bottle plug on the start tank sphere. The sleeve on pipe assembly, P/N 558268, was repaired, and the weld on pipe assembly, P/N 558269, was rewelded. The leaking seals on valve assembly, P/N 557998, were replaced. All rework was accomplished by Rocketdyne personnel, and was acceptable for use.

Five revisions were made to the procedure:

a. Two revisions changed the procedure to initially pressurize the pneumatic control sphere to 245 +10, -20 psig, rather than to the specified 700 $\pm$50 psia; and, after the engine control sphere fill and outlet lines were leak checked, to vent the engine control sphere and reduce the GSE supply pressure, both to between 225 and 250 psig. These changes provided a 4 to 1 safety factor for the engine components when higher pressures were not required.

4.2.27 (Continued)

b. One revision added a note that a leak check of the components within the pneumatic control package was not required unless directed by propulsion engineering, to clarify the requirements.

c. One revision repeated the control sphere pressurization and venting, the power turn on, and the solenoid energization, in order to pressurize pipe assembly, P/N 558270, for a retest following the correction of the noted leakage.

d. One revision added the requirement that all engine flanged connections provided with leak detection ports were to be leak tested using a Rocketdyne Model G3104 pneumatic flow tester. The connection was to be considered acceptable if no flow was indicated. This was to conform to the Rocketdyne R-3525-2 technical manual requirements.

4.2.28 Hydraulic System (1B59485 E)

This automatic procedure verified the integrity of the stage hydraulic system, and demonstrated the capability of the system to provide engine centering and control during powered flight. The test involved all components of the stage hydraulic system, including the hydraulic pump, P/N 1A66240-503, S/N X457803; the auxiliary hydraulic pump, P/N 1A66241-509, S/N X454664; the accumulator/reservoir assembly, P/N 1B29319-519, S/N 30; the hydraulic pitch actuator 401A1A1, P/N 1A66248-507-012, S/N 65; and the hydraulic yaw actuator 401A2A1, P/N 1A66248-507-012, S/N 64.

Initiated on 14 August 1967, the procedure was satisfactorily completed by the fifth attempt on 31 August 1967 after 5 days of activity, and was accepted on 1 September 1967. The first four attempts were not acceptable because of minor GSE and program problems, and a hydraulic system pressure loss problem. The minor problems were corrected for the fifth attempt, and the hydraulic pitch actuator, P/N 1A66248-507-012, S/N 66, was rejected by FARR A261324 for suspected oil leakage. A new pitch actuator, S/N 65, was installed before the fifth attempt. Those function values measured during the successful fifth attempt are presented in Test Data Table 4.2.28.1. All of these values were acceptable and were within general design requirements, although specific limit requirements were not defined in the procedure for most of the measurements.

The stage power setup, H&CO 1B59590, was accomplished, and initial conditions were established for the test. The instrument unit (IU) substitute 5 volt

4.2.28 (Continued)

power supply was turned on and its voltage was measured, and the aft 5 volt excitation module voltage was measured. Measurements were made of various hydraulic system functions with the hydraulic system unpressurized. Measurements were also made to determine the accumulator/reservoir gaseous nitrogen mass and corrected oil level.

The methods of controlling the auxiliary hydraulic pump were checked next. After verification that a power cable was connected to the auxiliary hydraulic pump motor, the aft bus 2 power supply was turned on and the bus voltage was verified to be 56.0 ±4.0 vdc. The coast mode operation was checked by applying dry ice to the coast mode thermal switch and verifying that the low temperature caused the thermal switch to turn the auxiliary pump on when the auxiliary hydraulic pump coast command was turned on. The dry ice was removed, and it was verified that the increased temperature caused the thermal switch to turn the pump back off. The coast command and the aft bus 2 power supply were turned off, and the bus voltage was verified to be 0.0 ±1.0 vdc. During the remaining pump control checks, only the auxiliary hydraulic pump motor ON indication was checked, as the pump did not run while the aft bus 2 power was off. The flight mode operation was checked by verifying that turning the auxiliary hydraulic pump flight command on and off properly turned the auxiliary pump on and off. The manual mode operation was checked by verifying that the auxiliary pump could be properly turned on and off at the GSE mechanical systems panel when the GSE was in the manual mode.

The engine centering tests were then conducted. The first test was conducted with the actuator position locks on and with the hydraulic system unpressurized. The actuator positions and the voltages of the IU substitute 5 volt power supply and the aft 5 volt excitation module were measured, and the corrected actuator positions were determined. The pitch and yaw actuator locks were then removed, and the aft bus 2 power was turned on and the voltage was measured. The auxiliary hydraulic pump was turned on in the automatic mode, and the aft bus 2 current was measured. The increase in hydraulic system pressure over a 4 second period was measured, and the various hydraulic system functions were verified to be within their proper operating limits.

4.2.28 (Continued)

With the hydraulic system pressurized, the second engine centering test was conducted with the actuator locks off and with no excitation signal applied to the actuators. The test measurements were repeated as before, and the corrected actuator positions were again determined. A zero excitation signal was then applied to the actuators, the hydraulic system functions were measured, the actuator position measurements were repeated, and the corrected actuator positions were again determined.

A clearance, linearity, and polarity check was accomplished next. The actuators were individually extended to their stops, then retracted, causing the engine to move out to its extremes of travel, 0 degrees to $\pm$7-1/2 degrees, in a square pattern, counterclockwise as viewed from the engine bell. The engine was then returned to its 0 degree centered position. As the engine was sequenced through the square pattern, a clearance check verified that there was no interference to engine motion within the gimbal envelope. A comparison of the hydraulic servo engine positioning system command and response signals verified that the response movement was of the correct polarity and magnitude to agree with the command signal, and met the requirements for movement linearity. Checks of the hydraulic system pressure and the reservoir oil pressure, made when the actuators were at their extremes and when they were returned to neutral, verified that these pressures remained acceptable.

Transient response tests were conducted next. Step commands were separately applied to the pitch and yaw actuators, causing each actuator to individually move the engine from 0 degrees to -3 degrees, from -3 degrees to 0 degrees, from 0 degrees to +3 degrees, and from +3 degrees to 0 degrees. The engine response was observed visually and audibly for unwanted oscillations, and the actuator responses were recorded during the engine movement. The engine slew rates were computed for each of the step movements. The Test Data Table shows the computed slew rates and representative actuator response values for the initial period of each check. The values measured were all acceptable and within general design requirements, although specific limits were not discernible from the procedure.

4.2.28 (Continued)

After the transient response test was completed, final measurements were made of the hydraulic system functions and the engine centering functions with the hydraulic system pressurized, the actuator locks off, and no excitation signals applied to the actuators.

The procedure was completed by turning off the auxiliary hydraulic pump, aft bus 2, and the IU substitute 5 volt power supply. The pitch and yaw actuator locks were then replaced. The computer printout noted that during this procedure the switch selector was cycled 4 times; the auxiliary hydraulic pump accumulated 2 cycles and 36 minutes, 10.108 seconds running time; and the engine accumulated 1.5 cycles of 7.5 degrees amplitude and 2 cycles of 3 degrees amplitude in the pitch plane, and 1 cycle of 7.5 degrees amplitude and 2 cycles of 3 degrees amplitude in the yaw plane.

Engineering comments noted that there were no parts shortages affecting this test. As noted, the problems encountered during the earlier attempts were all corrected before the fifth attempt. The only problem encountered during the last attempt was that the paper in the GSE computer lineprinter tore during the transient response test, and the original data on this test was lost. After the paper was replaced, a program backup was performed, and the transient response test was re-accomplished satisfactorily.

One FARR was written during this procedure, prior to the fifth attempt. FARR A261324 rejected the pitch hydraulic actuator, P/N 1A66248-507-012, S/N 66, for suspected oil leakage past the actuator piston seal. During the test, the hydraulic system pressure dropped to 3310 psia, below the allowable minimum pressure of 3310.06 to 3400 psia. A new actuator, S/N 65, was installed and satisfactorily tested.

Two revisions were made to the procedure, both to correct errors in the Running Time/Cycle Record paragraph. The words "engine-mounted" were deleted from the auxiliary hydraulic pump reference; the auxiliary hydraulic pump part number was changed from P/N 1A66241-507 to be P/N 1A66241-509; a note was added to record the auxiliary pump on-off cycles as well as the pump running time; and the switch selector, P/N 50M67864-5, was added as a cycle significant item.

4.2.28.1 Test Data Table, Hydraulic System

Function	Measurement	Limits
IU Substitute 5 volt Power Supply (vdc)	5.03	5.00 ± 0.05
Aft 5 Volt Excitation Module (vdc)	5.01	5.00 ± 0.05
Hydraulic System Unpressurized		
Reservoir Oil Pressure (psia)	75.50	*
Accumulator GN_2 Pressure (psia)	2405.56	*
Accumulator GN_2 Temperature (°F)	83.90	*
Reservoir Oil Level (%)	91.45	*
Pump Inlet Oil Temperature (°F)	81.94	*
Reservoir Oil Temperature (°F)	86.64	*
Aft Bus 2 Current (amp)	0.20	*
Gaseous Nitrogen Mass (lb)	1.913	1.925 ± 0.2
Corrected Reservoir Oil Level (%)	99.9	95.0 min.
Engine Centering Test, Locks On, System Unpressurized		
T/M Pitch Actuator Position (deg)	-0.02	*
IU Pitch Actuator Position (deg)	-0.07	*
T/M Yaw Actuator Position (deg)	0.02	*
IU Yaw Actuator Position (deg)	0.07	*
IU Substitute 5 volt Power Supply (vdc)	5.04	*
Aft 5 volt Excitation Module (vdc)	5.02	*
Pitch Actuator Signal (ma)	0.05	*
Yaw Actuator Signal (ma)	-0.05	*
Corrected T/M Pitch Actuator Position (deg)	0.012	-0.236 to 0.236
Corrected IU Pitch Actuator Position (deg)	-0.016	-0.236 to 0.236
Corrected T/M Yaw Actuator Position (deg)	-0.012	-0.236 to 0.236
Corrected IU Yaw Actuator Position (deg)	0.016	-0.236 to 0.236
Aft Bus 2 Voltage (vdc)	56.32	56.0 ± 4.0
Aft Bus 2 Current (amp)	59.00	55.0 ± 30.0
Hyd. System 4 Second Press. Change (psia)	291.3	200.0 min.
Engine Centering Test, Locks Off, System Pressurized, No Excitation Signal		
T/M Pitch Actuator Position (deg)	0.03	*
IU Pitch Actuator Position (deg)	-0.03	*
T/M Yaw Actuator Position (deg)	-0.08	*
IU Yaw Actuator Position (deg)	-0.07	*
IU Substitute 5 volt Power Supply (vdc)	5.04	*
Aft 5 volt Excitation Module (vdc)	5.02	*
Pitch Actuator Signal (ma)	0.05	*
Yaw Actuator Signal (ma)	0.00	*

* Limits Not Specified

4.2.28.1 (Continued)

Function	Measurement	Limits
Corrected T/M Pitch Actuator Position (deg)	0.058	-0.517 to 0.517
Corrected IU Pitch Actuator Position (deg)	0.029	-0.517 to 0.517
Corrected T/M Yaw Actuator Position (deg)	-0.105	-0.517 to 0.517
Corrected IU Yaw Actuator Position (deg)	-0.132	-0.517 to 0.517

Hydraulic System Pressurized, Locks Off, Zero Excitation Signal Applied to Actuators

Function	Measurement	Limits
Hydraulic System Pressure (psia)	3581.75	*
Reservoir Oil Pressure (psia)	170.21	*
Accumulator GN_2 Pressure (psia)	3605.75	*
Accumulator GN_2 Temperature (°F)	101.57	*
Reservoir Oil Level (%)	43.75	*
Pump Inlet Oil Temperature (°F)	96.46	*
Reservoir Oil Temperature (°F)	95.28	*
Aft Bus 2 Current (amp)	43.00	*
T/M Pitch Actuator Position (deg)	0.03	*
IU Pitch Actuator Position (deg)	-0.06	*
T/M Yaw Actuator Position (deg)	-0.06	*
IU Yaw Actuator Position (deg)	-0.04	*
IU Substitute 5 volt Power Supply (vdc)	5.04	*
Aft 5 volt Excitation Module (vdc)	5.02	*
Pitch Actuator Signal (ma)	0.05	*
Yaw Actuator Signal (ma)	-0.15	*
Corrected T/M Pitch Actuator Position (deg)	0.058	-0.517 to 0.517
Corrected IU Pitch Actuator Position (deg)	-0.001	-0.517 to 0.517
Corrected T/M Yaw Actuator Position (deg)	-0.090	-0.517 to 0.517
Corrected IU Yaw Actuator Position (deg)	-0.103	-0.517 to 0.517

Pitch 0 to -3 Degree Step Response - Engine Slew Rate: 15.6 deg/sec

Time from Start (sec)	Pitch Excitation Signal (ma)	IU Pitch Actuator Pot. Pos. (deg)	IU 5 Volt Power Supply (vdc)
0.000	0.000	-0.135	5.034
0.028	-19.971	-0.533	5.034
0.057	-19.873	-0.923	5.034
0.085	-19.873	-1.342	5.034
0.113	-19.971	-1.817	5.039
0.142	-19.873	-2.265	5.034
0.170	-19.873	-2.626	5.034
0.198	-19.922	-2.856	5.039
0.227	-19.922	-2.943	5.034
0.255	-19.873	-3.001	5.034
0.282	-19.922	-3.029	5.034
0.312	-19.873	-3.001	5.034

* Limits not Specified

4.2.28.1 (Continued)

Pitch -3 to 0 Degree Step Response - Engine Slew Rate: 14.9 deg/sec

Time from Start (sec)	Pitch Excitation Signal (ma)	IU Pitch Actuator Pot. Pos. (deg)	IU 5 volt Power Supply (vdc)
0.000	-19.899	-3.104	5.039
0.026	0.000	-2.597	5.034
0.055	0.000	-2.250	5.039
0.084	0.000	-1.803	5.029
0.111	0.049	-1.385	5.029
0.141	-0.049	-0.908	5.034
0.169	0.000	-0.505	5.029
0.196	0.000	-0.230	5.029
0.225	0.049	-0.115	5.024
0.253	0.000	-0.086	5.034
0.282	0.000	-0.129	5.029
0.310	-0.146	-0.144	5.029

Pitch 0 to +3 Degree Step Response - Engine Slew Rate: 14.7 deg/sec

Time from Start (sec)	Pitch Excitation Signal (ma)	IU Pitch Actuator Pot. Pos. (deg)	IU 5 volt Power Supply (vdc)
0.000	0.000	-0.089	5.034
0.027	19.775	0.376	5.029
0.056	19.775	0.736	5.034
0.083	19.775	1.126	5.039
0.112	19.678	1.573	5.029
0.141	19.775	2.050	5.039
0.168	19.727	2.425	5.034
0.196	19.775	2.670	5.034
0.226	19.775	2.771	5.029
0.253	19.775	2.771	5.034
0.281	19.678	2.771	5.034
0.311	19.727	2.742	5.024

Pitch +3 to 0 Degree Step Response - Engine Slew Rate: 15.2 deg/sec

Time from Start (sec)	Pitch Excitation Signal (ma)	IU Pitch Actuator Pot. Pos. (deg)	IU 5 volt Power Supply (vdc)
0.000	19.750	2.819	5.029
0.027	0.049	2.367	5.029
0.055	0.000	1.992	5.034
0.084	0.049	1.573	5.034
0.112	0.000	1.097	5.039
0.141	0.000	0.664	5.034
0.168	0.049	0.289	5.029
0.197	0.049	0.059	5.039
0.226	0.000	-0.058	5.034
0.253	0.000	-0.071	5.034
0.281	0.000	-0.086	5.029
0.311	0.000	-0.086	5.034

4.2.28.1 (Continued)

Yaw 0 to -3 Degree Step Response - Engine Slew Rate: 14.1 deg/sec

Time from Start (sec)	Yaw Excitation Signal (ma)	IU Yaw Actuator Pot. Pos. (deg)	IU 5 volt Power Supply (vdc)
0.000	- 0.050	-0.015	5.034
0.027	-19.922	-0.419	5.029
0.055	-19.873	-0.779	5.039
0.083	-19.922	-1.141	5.039
0.112	-19.922	-1.603	5.034
0.141	-19.873	-2.050	5.039
0.169	-19.922	-2.439	5.034
0.197	-19.922	-2.713	5.029
0.226	-19.922	-2.828	5.039
0.253	-19.971	-2.857	5.039
0.281	-19.922	-2.872	5.039
0.311	-20.020	-2.872	5.029

Yaw -3 to 0 Degree Step Response - Engine Slew Rate: 14.7 deg/sec

Time from Start (sec)	Yaw Excitation Signal (ma)	IU Yaw Actuator Pot. Pos. (deg)	IU 5 Volt Power Supply (vdc)
0.000	-19.850	-2.955	5.034
0.027	- 0.146	-2.482	5.039
0.055	0.000	-2.107	5.034
0.083	- 0.244	-1.718	5.034
0.112	- 0.146	-1.256	5.034
0.140	- 0.146	-0.794	5.034
0.168	0.000	-0.434	5.029
0.197	0.000	-0.188	5.034
0.225	- 0.146	-0.102	5.039
0.253	0.000	-0.059	5.029
0.281	- 0.146	-0.029	5.039
0.310	- 0.146	0.000	5.034

Yaw 0 to +3 Degree Step Response - Engine Slew Rate: 14.9 deg/sec

Time from Start (sec)	Yaw Excitation Signal (ma)	IU Yaw Actuator Pot. Pos. (deg)	IU 5 Volt Power Supply (vdc)
0.000	- 0.199	0.044	5.034
0.027	19.775	0.476	5.039
0.056	19.775	0.822	5.039
0.084	19.824	1.240	5.029
0.112	19.775	1.688	5.039
0.140	19.824	2.135	5.034
0.168	19.824	2.539	5.029
0.197	19.775	2.756	5.034
0.225	19.775	2.886	5.034
0.253	19.824	2.929	5.034
0.281	19.824	2.972	5.034
0.310	19.824	2.957	5.034

4.2.28.1 (Continued)

Yaw +3 to 0 Degree Step Response - Engine Slew Rate: 14.3 deg/sec

Time from Start (sec)	Yaw Excitation Signal (ma)	IU Yaw Actuator Pot. Pos. (deg)	IU 5 volt Power Supply (vdc)
0.000	19.800	3.089	5.029
0.026	0.000	2.611	5.029
0.055	- 0.146	2.294	5.029
0.084	- 0.146	1.861	5.034
0.111	- 0.146	1.413	5.039
0.140	- 0.146	0.966	5.029
0.169	- 0.146	0.548	5.034
0.196	0.000	0.245	5.029
0.225	- 0.195	0.101	5.039
0.253	- 0.146	0.058	5.034
0.281	- 0.098	0.086	5.039
0.310	- 0.146	0.058	5.039

Final Hydraulic System and Engine Centering Test
System Pressurized, Locks Off, No Excitation Signal

Function	Measurement	Limits
Hydraulic System Pressure (psia)	3571.88	*
Reservoir Oil Pressure (psia)	171.95	*
Accumulator GN_2 Pressure (psia)	3616.63	*
Accumulator GN_2 Temperature (°F)	92.14	*
Reservoir Oil Level (%)	48.49	*
Pump Inlet Oil Temperature (°F)	157.30	*
Reservoir Oil Temperature (°F)	149.36	*
Aft Bus 2 Current (amps)	44.80	*
T/M Pitch Actuator Position (deg)	-0.08	*
IU Pitch Actuator Position (deg)	-0.13	*
T/M Yaw Actuator Position (deg)	0.00	*
IU Yaw Actuator Position (deg)	0.07	*
IU Substitute 5 volt Power Supply (vdc)	5.03	*
Aft 5 volt Excitation Module (vdc)	5.02	*
Pitch Actuator Signal (ma)	0.05	*
Yaw Actuator Signal (ma)	-0.05	*
Corrected T/M Pitch Actuator Position (deg)	-0.051	-0.517 to 0.517
Corrected IU Pitch Actuator Position (deg)	-0.083	-0.517 to 0.517
Corrected T/M Yaw Actuator Position (deg)	-0.027	-0.517 to 0.517
Corrected IU Yaw Actuator Position (deg)	0.022	-0.517 to 0.517

* Limits not Specified

4.2.29 Range Safety Receiver Checks (1B59596 E)

This combined manual and automatic procedure verified the functional capabilities of the range safety receivers prior to their use in the range safety system checkout. The receivers were checked for automatic gain control (AGC) calibration and drift, minimum acceptable deviation sensitivity, minimum acceptable RF sensitivity, and open loop operation. The items involved in this test were:

Item	Ref. Location	P/N	S/N
Range Safety Receiver 1	411A97A14	50M10697	107
Range Safety Receiver 2	411A97A18	50M10697	108
Secure Command Decoder 1	411A99A1	50M10698	102
Secure Command Decoder 2	411A99A2	50M10698	21

Initiated on 22 August 1967, the procedure was completed by the third attempt on 23 August 1967, and was accepted on 30 August 1967. The first two attempts were not successful because of GSE problems with the PAM ground station and the computer. The following narration and Test Data Table 4.2.29.1 cover the acceptable third attempt.

Several manual operations were accomplished before the automatic procedure was started. The total cable insertion loss values at the 450 MHz range safety frequency were found to be 28.5 db for range safety system 1, and 28.2 db for range safety system 2. The Model DSV-4B-136 destruct system test set, P/N 1A59952-1, was set up at 450.000 $\pm$0.045 MHz with a -17 dbm output level and a 60.00 $\pm$0.60 kHz deviation. The stage range safety antennas were disconnected from the directional power divider, and 50 ohm loads were connected to the power divider in their place for test use until the open loop RF checks.

Initial test conditions were established, the range safety receivers were transferred to external power and turned on, and the propellant dispersion cutoff command inhibit was turned on for both receivers. The cable insertion loss values were loaded into the computer for use in the program.

The receiver AGC calibration checks were conducted next. For each input signal level used in the calibration check, the computer determined the GSE test set output level required to compensate for the cable insertion loss, and, when requested by the computer typeout, the GSE test set was manually adjusted to these output levels. The computer then determined the input signal levels and

4.2.29 (Continued)

measured the low level signal strength (AGC telemetry voltage) of each receiver. These AGC measurements, in the 0 to 5 vdc range, were multiplied by a conversion factor of twenty and presented as percent of full scale values. The AGC calibration check was conducted twice, and the difference in AGC values at each step was determined for the AGC drift check. As shown in the Test Data Table, the AGC values were all acceptable, and the drift deviations were well below the 3 percent of full scale maximum limit.

Manual -3 db and -60 db RF bandwidth checks were individually conducted on each receiver. With a GSE test set output frequency of 450.000 ±0.005 MHz, the output level was adjusted to obtain a 2.0 ±0.1 vdc AGC voltage from the receiver under test. The corresponding receiver RF output level was determined, and +20 dbm was added to obtain the RF reference level. The GSE test set output level was increased by 3 db, and the test set frequency was increased above 450 MHz, and then decreased below 450 MHz, until the receiver AGC voltage was again 2.0 ±0.1 vdc. The frequencies at which this occurred were measured as the upper and lower -3 db bandedge frequencies. The -3 db bandwidth was found as the difference between these frequencies, and the bandwidth centering was found as the difference between the midpoint of these frequencies and 450 MHz. For the -60 db bandwidth check, this procedure was repeated, except that the test set output level was increased by 60 db rather than 3 db. The results of these checks are shown in the Test Data Table.

For the deviation threshold check, the GSE test set was adjusted for an output of 450.000 ±0.045 MHz at a level that provided receiver input levels of -63 dbm for receiver 1, and -62.7 dbm for receiver 2. A series of checks determined the minimum input deviation frequency at which each receiver would respond to the range safety commands. For each command, the GSE test set was manually adjusted to a sequence of deviation frequencies increasing from 5 kHz, as requested by the computer typeout. At each deviation frequency, the range safety secure command decoders were checked for the presence of the command signal from the appropriate receiver. As shown in the Test Data Table, both receivers responded to all commands at minimum deviation frequencies well below the 50 kHz maximum limit.

4.2.29 Range Safety Receiver Checks (1B59596 E)

This combined manual and automatic procedure verified the functional capabilities of the range safety receivers prior to their use in the range safety system checkout. The receivers were checked for automatic gain control (AGC) calibration and drift, minimum acceptable deviation sensitivity, minimum acceptable RF sensitivity, and open loop operation. The items involved in this test were:

Item	Ref. Location	P/N	S/N
Range Safety Receiver 1	411A97A14	50M10697	107
Range Safety Receiver 2	411A97A18	50M10697	108
Secure Command Decoder 1	411A99A1	50M10698	102
Secure Command Decoder 2	411A99A2	50M10698	21

Initiated on 22 August 1967, the procedure was completed by the third attempt on 23 August 1967, and was accepted on 30 August 1967. The first two attempts were not successful because of GSE problems with the PAM ground station and the computer. The following narration and Test Data Table 4.2.29.1 cover the acceptable third attempt.

Several manual operations were accomplished before the automatic procedure was started. The total cable insertion loss values at the 450 MHz range safety frequency were found to be 28.5 db for range safety system 1, and 28.2 db for range safety system 2. The Model DSV-4B-136 destruct system test set, P/N 1A59952-1, was set up at 450.000 ±0.045 MHz with a -17 dbm output level and a 60.00 ±0.60 kHz deviation. The stage range safety antennas were disconnected from the directional power divider, and 50 ohm loads were connected to the power divider in their place for test use until the open loop RF checks.

Initial test conditions were established, the range safety receivers were transferred to external power and turned on, and the propellant dispersion cutoff command inhibit was turned on for both receivers. The cable insertion loss values were loaded into the computer for use in the program.

The receiver AGC calibration checks were conducted next. For each input signal level used in the calibration check, the computer determined the GSE test set output level required to compensate for the cable insertion loss, and, when requested by the computer typeout, the GSE test set was manually adjusted to these output levels. The computer then determined the input signal levels and

4.2.29 (Continued)

range safety EBW firing units were transferred to external power, the propellant dispersion cutoff command inhibits were turned off for both receivers, and the range safety receivers were both turned off, completing the range safety receiver checks. The computer printout indicated that both range safety receivers had accumulated 2 hours 29 minutes 38.505 seconds running time during this test attempt, and that the switch selector was used 4 times.

Engineering comments noted that there were no parts shortages affecting this test. One problem was encountered during the third attempt. At one point in the procedure the Model DSV-4B-125 PAM/FM/FM telemetry ground station, P/N 1A59942-1, was in the manual operation mode when it should have been set for automatic operation. The program was interrupted until this was corrected. No stage problems were encountered, and no FARR's were written. Twenty-two revisions were made to the procedure:

a. Two revisions corrected errors made in rewriting and assembling the E revision of this procedure. The existing handling, equipment setup, and general checkout instructions were deleted, and seven pages of instructions were added to provide the proper manual operations. Also, the paragraphs covering the H&CO scope, purpose, and description, and the range safety system purpose and description, were changed to reflect the concept of combined manual and automatic test procedures. These changes were to meet the requirements of revision A to the test requirements drawing, 1B64706.

b. One revision added government documents 50M10697, Secure Command Receiver MCR-503, and 50M10698, Secure Range Safety Decoder, and DAC documents 1B56559, Secure Command Receiver MCR-503, and 1B56560, Secure Range Safety Decoder, to the Miscellaneous Applicable Documents paragraph.

c. Eight revisions changed the End Item Equipment lists to agree with the test requirements drawing, 1B64706, and to reflect changes to the basic equipment drawings. On the Mandatory End Items list, the Model DSV-4B-268 aft interface substitute unit chassis, P/N 1A89815-1, was deleted as unnecessary for this test, and two units, the Model DSV-4B-125 PAM/FM/FM telemetry ground station, P/N 1A59942-1, and the Model DSV-4B-192 open loop CDR antenna, P/N 1B53355-1, were added as required items. On the A3 VCL 1

4.2.29 (Continued)

additional items list, the Model DSV-4B-726A electrical checkout adapter accessory kit, P/N 1B55449-1, was added, and the Model DSV-4B-184A electrical checkout accessory kit, P/N 1B44042-1, was retitled electrical checkout accessory kit A3 VCL 1. On the A3 VCL 2 additional items list, the Model DSV-4B-726B electrical checkout adapter accessory kit, P/N 1B55450-1, was added, and the Model DSV-4B-184B electrical checkout accessory kit, P/N 1B44044-1, was retitled electrical checkout accessory kit A3 VCL 2. On the A45 VCL additional items list, the Model DSV-4B-726E electrical checkout adapter accessory kit, P/N 1B55453-1, was added, and the Model DSV-4B-184E electrical checkout accessory kit, P/N 1B44048-1, was retitled electrical checkout accessory kit A45 VCL.

d. Three revisions changed the Running Time/Cycle Record paragraph to note that at the end of the test the lineprinter would print the running time of the range safety receivers, P/N 50M10697, and the cycles accumulated by the switch selector, P/N 50M67864-5; and to delete the EBW firing units, P/N's 40M39515-113 and -119, from the paragraph, as the firing units were not used during this test.

e. Two revisions made minor changes to the manual setup instructions, to correct procedure and typing errors.

f. Two revisions changed the cable insertion loss manual operations to accomplish the test properly, and to make the test setups identical for the two insertion loss measurements.

g. One revision changed an expected frequency counter indication to be 60.00 $\pm$00.60 kHz rather than 60.00 $\pm$000.6000 kHz, to reflect the desired accuracy and capability of the equipment. This change was in response to NASA letter R-QUAL-P/DAC-231/Goodman, dated 8 August 1967.

h. One revision changed the program to define the proper method of verifying that the open loop PCM RF signal was received by the GSE ground station.

i. One revision set the source selector switch on the RF DDAS panel of the Model DSV-4B-123 DDAS ground station to position 1 when the PCM RF assembly power was turned off, so that telemetry data could be received at the ground station when the PCM/FM transmitter was off.

j. One revision deleted a redundant print statement.

4.2.29.1 Test Data Table, Range Safety Receivers Checks

AGC Calibration and Drift Checks (% = percent of full scale)

Test Set Output (dbm)	Receiver 1 Input (dbm)	AGC 1 (%) Run 1	AGC 1 (%) Run 2	Drift	Receiver 2 Input (dbm)	AGC 2 (%) Run 1	AGC 2 (%) Run 2	Drift
-98.5	-127.0	7.07	7.07	0.00	-126.7	17.73	18.05	0.31
-91.5	-120.0	7.48	7.27	0.21	-119.7	18.05	17.93	0.12
-86.5	-115.0	8.20	8.20	0.00	-114.7	19.06	18.75	0.31
-81.5	-110.0	10.14	10.25	0.12	-109.7	21.02	20.61	0.41
-76.5	-105.0	16.00	15.47	0.53	-104.7	26.86	25.94	0.92
-71.5	-100.0	27.48	27.48	0.00	-99.7	39.28	39.57	0.29
-66.5	-95.0	50.55	49.53	1.02	-94.7	60.29	60.29	0.00
-61.5	-90.0	67.58	67.48	0.10	-89.7	69.32	69.43	0.12
-56.5	-85.0	70.25	70.14	0.12	-84.7	70.76	70.66	0.10
-51.5	-80.0	70.76	70.76	0.00	-79.7	71.27	71.27	0.00
-46.5	-75.0	71.07	71.07	0.00	-74.7	71.58	71.58	0.00
-41.5	-70.0	71.27	71.17	0.10	-69.7	71.58	71.68	0.10

-3 db RF Bandwidth Check

Function	Receiver 1	Receiver 2	Limits
Reference Voltage (AGC) (vdc)	2.0	2.0	2.0 ±0.1
Reference RF Power Level (dbm)	-69.0	-71.8	*
Upper Bandedge Frequency (MHz)	450.144	450.131	*
Lower Bandedge Frequency (MHz)	449.827	449.816	*
-3 db Bandwidth (kHz)	317.0	315.0	340.0 ±30.0
Bandwidth Centering (kHz)	18.0	26.0	33.8 max.

-60 db RF Bandwidth Check

Function	Receiver 1	Receiver 2	Limits
Reference Voltage (AGC) (vdc)	2.0	2.0	2.0 ±0.1
Reference RF Power Level (dbm)	-69.0	-71.8	*
Upper Bandwidth Frequency (MHz)	450.484	450.491	*
Lower Bandwidth Frequency (MHz)	449.483	449.517	*
-60 db Bandwidth (MHz)	1.001	0.974	1.2 max.

Deviation Sensitivity Check

Range Safety Command	Minimum Deviation (kHz) Receiver 1	Minimum Deviation (kHz) Receiver 2
Arm and Engine Cutoff	12.5	10.0
Propellant Dispersion	12.5	10.0
Range Safety System Off	12.5	10.0

RF Sensitivity Check

Range Safety Command	Minimum Input Level (dbm) Receiver 1	Minimum Input Level (dbm) Receiver 2
Arm and Engine Cutoff	-105.0	-99.7
Propellant Dispersion	-110.0	-104.7
Range Safety System Off	-105.0	-104.7

*Limits Not Specified

4.2.30 Propulsion System Test (1B64390 E)

This automatic procedure performed the integrated electro-mechanical functional tests of the stage propulsion system. The procedure was divided into five sections, each of which was performed separately. The first section of the test checked the pressure switches for activation, deactivation, and proper control functions. The second section checked the pneumatic control system for functional capability and valve operation. The third section verified the operation of the LOX tank pressurization system, and the fourth section verified the operation of the LH_2 tank pressurization system. The fifth section of the test was a four part check of the J-2 engine spark ignition system, cutoff logic and delay timer, and engine control helium bottle and valves. The procedure involved all components of the stage propulsion system, including the J-2 engine.

Initiated on 22 August 1967, the procedure was completed on 25 August 1967 after 4 days of activity, and was accepted on 30 August 1967. The sections of the procedure are presented in order. Measurements made during the procedure are shown in Test Data Table 4.2.30.1.

Section 1, the pressure switch test, was completed on the third attempt on 24 August 1967. The first two attempts were not acceptable because of several malfunctions. These were corrected by removing a cap from the LOX tank pressure line orifice, venting the LOX chilldown lines, and reducing the pressure change required to verify valve operation. The ambient helium sphere dump valve, ambient helium supply shutoff valve, cold helium dump valve, cold helium supply shutoff valve, LOX chilldown pump purge control and dump valves, and the engine pump purge control valve were actuated to ensure proper operation. Then the cold helium regulator backup pressure switch and the control helium regulator backup pressure switch were checked for pickup and dropout pressures after pressurizing the GSE stage 2 regulator to 650 $\pm$25 psia. These pressures are listed in the Test Data Table.

Section 2, the pneumatic control system test, was completed on the first attempt on 24 August 1967. The control helium sphere was pressurized to 700 $\pm$50 psia and the control helium regulator discharge pressure was set at 515 $\pm$50 psia, and both pressures were measured. Then the opening and closing times

4.2.30 (Continued)

for the LOX and LH_2 vent valves, fill and drain valves, prevalves, and chilldown shutoff valves were measured. The time for the LH_2 directional control vent valve to go to the flight position and activation time for it to go to the ground position were also measured. These measurements are recorded in the Test Data Table. The last check performed in Section 2 was a check of the switch selector for each of the above valves.

The next test was the LOX tank pressurization system test, Section 3, performed on 24 August 1967, on the third attempt. The first two attempts were terminated because of problems with the computer. After these were corrected, the third attempt was completed without problems.

The GSE stage 8 regulator was pressurized to 50 ± 5 psia and the line and dome pressures were measured. Pressure was applied to the system, and the pressure switch manifold pressurization time and the LOX tank ground fill pressure switch pickup pressures were measured. The cold helium supply shutoff valve was opened and it was verified that the flight control pressure switch would close the cold helium shutoff valve. Then it was verified that the LOX tank flight pressure on command would open the cold helium shutoff valve.

It was next verified that the coast period on command would close the cold helium shutoff valve, and that the coast period off command opened the cold helium shutoff valve. The LOX tank flight pressure system on command was turned off, then the stage 8 regulator bleed valve was opened, the pressure switch manifold depressurization time was measured, and the LOX ground fill pressure switch dropout pressure was measured. The operation of the heat exchanger bypass valves was verified.

The stage 8 regulator was pressurized to 50 ± 5 psia and the pressure switch manifold was pressurized and depressurized twice with the LOX tank pressure switch pickup and dropout pressures measured as the manifold was cycled. The cold helium system was pressurized to 700 psia, and four measurements were taken of the cold helium sphere pressure, D016, and the regulator flow test plenum pressure, D105, while the system was depressurizing. All of the above measurements are recorded in the Test Data Table.

4.2.30 (Continued)

Section 4, the LH_2 tank pressurization system test, was completed on the first attempt on 24 August 1967. This portion was begun by flowing prepressurization gas into the LH_2 tank. The LH_2 tank pressure module H_2 gas pressure was then measured before and after the LH_2 first burn relay was turned on, and it was verified that the LH_2 step pressure valve was closed when the LH_2 first burn relay on command was turned on. The next step was to pressurize the stage 7 regulator with helium to 50 $\pm$5 psia, close the stage 7 dome vent valve, open the dome load valve, and measure the resulting line and dome pressures.

Pressure was applied to the system and measurements were made of the pressure switch manifold pressurization time, and the LH_2 tank flight control, ground fill overpressure, and orbital coast vent high pressure switch pickup pressures. The LH_2 vent enable command was turned off and then on, and verified as operating properly. It was then verified that the LH_2 first burn bypass control valve was closed by the pressure switch pickup pressure.

Next the pressure switch manifold depressurization time and dropout pressures for the above pressure switches were measured, as were the deadband pressures for the LH_2 ground fill overpressure and LH_2 tank flight control pressure switches. Then the pressure switch dropout pressures which resulted in the LH_2 first burn bypass control valve opening, and the LH_2 step pressure valve opening by the first burn off command were measured. This completed the LH_2 prepressurization system valve functional test and the first cycle of the pressure switch pickup test. Two more cycles of the pressure switch pickup test were performed. All resulting measurements are shown in the Test Data Table.

Section 5, the J-2 engine system test, was accomplished on 25 August 1967 by the second attempt. The first attempt was not acceptable becaue of minor GSE problems. The following discussion is concerned with the second attempt, as is the test data in the Test Data Table.

With the propellant tanks at ambient temperature, the first portion of the J-2 engine system test verified that the emergency detection system (EDS) 1 engine

4.2.30 (Continued)

cutoff command resulted in an engine cutoff indication, a non-programmed engine cutoff indication, and a telemetry engine cutoff command indication (K140). Verification was then made that the EDS 2 engine cutoff command did not give a non-programmed engine cutoff indication, but turned the engine control bus power off and disabled the engine control bus power on command.

Next it was verified that the LOX and LH_2 prevalves and chilldown shutoff valves were held closed by the ground command. Then the engine ignition bus, engine control bus, and the component test power voltages were measured. The thrust chamber and gas generator spark systems 1 and 2 were verified to be operative.

For the start tank vent valve check, the start tank was pressurized and the pressure was measured. The start tank vent valve was opened, closed, and reopened. The resulting pressure differential was determined to be within the prescribed limits for proper vent valve operation.

For the engine cutoff checks, the component test power and the switch selector engine cutoff command were turned on, and it was verified that the engine cutoff indication was ON. The engine cutoff command was turned off, and it was verified that the engine cutoff lock was reset. The engine ignition bus power was then turned off and it was verified that the engine ready indication was OFF.

For the test of the engine ignition cutoff and LH_2 injection temperature detector bypass, a series of steps verified that the start tank discharge control indication and the engine start indication were ON only when the switch selector engine start command, the aft separate simulation 1 and 2, and the switch selector LH_2 injection temperature detector bypass were all turned on. The switch selector engine start command was turned off and it was verified that the engine cutoff indication was ON within a predetermined time limit. The engine ignition timer delay time was measured, and aft separate simulation 1 and 2 were turned off.

For the mainstage cutoff test an engine ignition and cutoff sequence was accomplished, and operating times of the helium delay timer, the spark

4.2.30 (Continued)

de-energize timer, and the start tank discharge timer, were measured. The ignition detection indication was verified to be ON when the engine cutoff was ON.

For the check of the mainstage OK pressure switches 1 and 2, the GSE stage 6 and stage 2 regulators were pressurized with helium, and the line and dome pressures were measured. Pressure from the stage 6 regulator was applied to mainstage OK pressure switch 1, and the pickup pressure was measured. The mainstage OK pressure switch 1 depressure indication and the engine thrust OK 1 and 2 indications were verified to be OFF. The engine start sequence was accomplished, and the ignition detected indication was verified to be ON. Pressure from the stage 2 regulator was applied to mainstage OK pressure switch 2, and the pickup pressure was measured. The pressure to switch 1 was reduced, and the dropout pressure was measured. The engine thrust OK 1 and 2 indications were verified to still be OFF, and it was verified that the dropout of switch 1 did not cause engine cutoff while switch 2 was picked up. The pressure to switch 2 was reduced, and the dropout pressure was measured. It was verified that the engine thrust OK 1 and 2 indications were ON, and that the dropout of both mainstage OK pressure switches had caused engine cutoff. The pressure switch check was repeated twice, while measurements were made of the line and dome pressures, and the pressure switch pickup and dropout pressures.

For the helium control solenoid valves check, the GSE stage 4 regulator and the control helium supply sphere were pressurized to 1450 $\pm$50 psia. The helium control solenoid valve was opened, and the engine regulator output pressure was measured through the AO and BO telemetry multiplexers. The LH_2 and LOX bleed valves were verified to be closed, and the engine main LH_2 valve closed position was measured. The ignition phase control solenoid valve was opened, verification was made that the engine ASI oxidizer valve and the engine main LH_2 valve were open, and the main LH_2 valve open position was measured. The start tank discharge valve closed position was measured, then the start tank solenoid valve was opened, the start tank discharge valve was verified to be open, and the open position was measured. The gas generator

4.2.30 (Continued)

valve and main LOX valve closed positions, and the LOX turbine bypass valve open position were measured. The mainstage control solenoid valve was opened, the gas generator valve was verified to be open, and the main LOX valve first ramp position was measured.

Verification was made that the gas generator valve was open and that the LOX turbine bypass valve was closed, and the respective open and closed positions were measured. The main LOX valve was verified to be open, and its open position was measured. The gas generator valve plateau position was measured. An engine valve telemetry talkback check verified that the engine ASI oxidizer valve open indication was ON; that the LH_2 and LOX bleed valve closed indications were ON, through the AO and BO multiplexers; and that the closed indications were all OFF for the main LH_2 and LOX valves, the gas generator valve, and the start tank discharge valve.

The start tank solenoid valve was closed, and the start tank discharge valve reclosed position was measured. The mainstage control solenoid valve was closed and it was verified that the main LOX valve and the gas generator valve were closed, that the LOX turbine bypass valve was open, and the respective reclosed and reopened positions of these valves were measured. The ignition phase control solenoid valve was closed, and it was verified that the engine ASI oxidizer valve and the engine main LH_2 valve were closed, then the main LH_2 valve reclosed position was measured. The helium control solenoid valve was closed and the LH_2 and LOX bleed valves were verified to be open.

A telemetry talkback check verified that the LH_2 and LOX bleed valve closed indications were OFF, through the AO and BO multiplexers, and that the closed indications were ON for the gas generator valve, the start tank discharge valve, and the main LH_2 and LOX valves.

For the final engine sequence check, the engine ignition bus power was turned on, the entire engine system was verified to be ready for the check, and the component test power was turned on. The engine sequence check was a completely automatic repetition of previous parts of the engine system test, where the necessary commands were given to cause engine start and engine cutoff, and the

4.2.30 (Continued)

system responses to the commands were verified to be within the predetermined proper limits. Various operating times were measured during the sequence to verify the proper operation of the system component items.

Engineering comments noted that there were no parts shortages affecting this test. No FARR's were written during the test, but Engineering comments noted several problems:

a. During the pressure switch tests, a malfunction printout indicated that the backup pressure transducer isolation supply valve did not open. The valve had opened, but erratic valve operation prevented the open indication from being measured within the 250 millisecond wait period. As the valve was a GSE item, the erratic opening did not adversely affect the test.

b. During the LH_2 tank pressurization test, a request for an illegal function number caused error indications, a safety item monitor interrupt, and a program backup. This problem was due to an operator error, and did not affect the test.

c. During the J-2 engine system test, no open indications were received for the LOX and LH_2 prevalves and chilldown shutoff valves during a backup routine at the end of the test. The actuation control module vent ports had been previously connected to the prevalve ground supply, and this prevented complete venting of the system, resulting in the false indications.

Fifteen revisions were made to the procedure:

a. Two revisions modified the initial equipment set up. A step to set the mainstage power switch to ENABLE was deleted, as there was no mainstage power switch. A hand valve part number was deleted from one step, to allow the use of other hand valves in the system.

b. Two revisions modified the preliminary setups for the LOX tank pressurization test and the J-2 engine test, to simplify the system setup, and to correct an error.

c. One revision added steps to the pressure switch test setup and securing, to allow checkout of the LOX chilldown pump purge module and dump valve.

d. One revision added a step during the J-2 engine test to connect a flex hose between the prevalve ground supply and the vent ports of the chilldown shutoff valve and prevalve actuation control module, to prevent the engine flowmeters from spinning during the engine sequence test.

e. Three revisions modified the J-2 engine spark system checks. A step was added to turn on the oscillograph for these checks, to correct a procedure omission, and three second delays were added at two places to allow data acquisition.

4.2.30 (Continued)

f. One revision corrected a procedure error by opening the ambient helium supply shutoff valve during a backup routine, rather than opening the helium control solenoid valve.

g. Two revisions modified the pressure switch test. A pressure increase requirement was changed from 15 psi to be 10 psi at two places, as a 10 psi increase was sufficient evidence of proper valve operation. Two steps were added to open and close the LOX chilldown pump purge dump valve before checking the pump purge module, to ensure ambient pressure in the LOX pump motor container.

h. Two revisions were required because the hydraulic system had been drained for replacement of the pitch hydraulic actuator. The hydraulic system pressure safety item monitor was deleted, and the hydraulic reservoir oil level low function was deleted from the initial conditions scan buffer table. The propulsion system test was not affected by the actuator replacement.

i. One revision deleted the oscillograph channel assignment table from the procedure, as the oscillograph setup and channel assignments were specified in the system setup document.

4.2.30.1 Test Data Table, Propulsion System Test

Section 1, Pressure Switches Test

Function	Measured Value (psia) Test 1	Test 2	Test 3	Limits (psia)
Stage 2 Line Pressure	662.8	659.0	651.6	650 ±25
Stage 2 Dome Pressure	677.6	677.6	670.2	
Cold He PS Pickup Pressure	459.3	458.5	459.3	467.5 ±23.5
Cold He PS Dropout Pressure	351.5	350.7	351.5	352.5 ±23.5
Control He PS Pickup Pressure	594.9	593.4	593.4	600 ±21
Control He PS Dropout Pressure	489.5	489.5	493.4	490 ±31

Section 2, Pneumatic Control System Test

Function	Measured Value (psia)	Limits (psia)
Control Helium Sphere Pressure	690	700 ±50
Control He Regulator Discharge Pressure	530	515 ±50

4.2.30.1 (Continued)

Function	Open	Total Open	Close	Total Close	Boost	Total Boost
	Operating Times (sec.)					
LH_2 Vent Valve	0.025	0.074	0.204	0.460	0.081	0.230
LOX Vent Valve	0.016	0.078	0.145	0.344	0.080	0.192
LOX Fill & Drain Valve	0.146	0.266	0.769	2.338	0.407	0.852
LH_2 Fill & Drain Valve	0.135	0.257	0.724	2.123	0.394	0.870
LOX Prevalve	1.224	1.718	0.246	0.401		
LH_2 Prevalve	1.423	2.109	0.253	0.400		
LOX CD Shutoff Valve	0.300	1.043	0.029	0.122		
LH_2 CD Shutoff Valve	0.400	1.396	0.075	0.196		

	Flight Pos.	Total Flight Pos.	Ground Pos.	Total Ground Pos.
LH_2 Directional Vent Valve	0.095	0.230	0.196	0.358

Section 3, LOX Tank Pressurization System Test

Pressure Switch Check

Function	Test 1	Test 2	Test 3	Limits
	Measured Value			
Stage 8 Line Pressure (psia)	47.23	47.23	47.23	50 ± 5
Stage 8 Dome Pressure (psia)	54.89	55.32	54.47	
Manifold Press. Time (sec.)	60.091	56.207	58.815	
Manifold Depress. Time (sec.)	177.047	173.877	174.959	
Ground Fill PS Pickup (psia)	39.96	39.85	39.96	41 max.
Ground Fill PS Dropout (psia)	37.29	37.13	37.13	36.5 min.
Ground Fill PS Range (psia)	2.67	2.72	2.83	0.5 min.

Heat Exchanger Bypass Valve Check

Function	Bypass Closed	Bypass Open
LOX Press. Module He Gas Press. (psia)	214.80	108.97
Cold He Control Valve Inlet Press. (psia)	198.98	69.69

4.2.30.1 (Continued)

Cold Helium Regulator Test

Function	Plenum Press. (psia)	He Sphere Press. (psia)
Cold Helium Repressure		694.05
First Measurement	403.01	655.86
Second Measurement	400.83	648.23
Third Measurement	403.01	636.78
Fourth Measurement	403.01	617.67

Section 4, LH_2 Tank Pressurization System Test

Pressure Switch Check

	Measured Value			
Function	Test 1	Test 2	Test 3	Limits
Stage 7 Line Pressure (psia)	46.91	46.59	46.59	50 $\pm$5
Stage 7 Dome Pressure (psia)	53.62	54.25	52.98	
Manifold Press. Time (sec.)	110.034	77.347	81.167	
Manifold Depress. Time (sec.)	146.978	147.709	146.588	
PS System Begin. Press. (psia)	39.33	39.22	39.22	39 min.
Flight Control PS Pickup (psia)	29.17	29.12	29.12	30.0 max.
Flight Control PS Dropout (psia)	27.31	27.36	27.26	26.5 min.
Flight Control PS Deadband (psia)	1.86	1.76	1.87	0.5 min.
Gnd. Fill Overpress. PS Pickup (psia)	33.84	33.68	33.73	34.5 max.
Gnd. Fill Overpress. PS Dropout (psia)	31.50	31.61	31.50	30.8 min.
Gnd. Fill Overpress PS Deadband (psia)	2.33	2.07	2.23	0.5 min.
Orb. Coast Vent Hi PS Pickup (psia)	35.39	35.29	35.29	35.00 $\pm$1.00
Orb. Coast Vent Hi PS Dropout (psia)	31.66	31.66	31.66	30.5 min.

Valve Functional Check

Valve Status	GH_2 Press. (psia)	Limit (psia)
Valves Open (A)	49.92	
Step Pressure Valve Closed (B)	87.01	(A) + 10 min.
First Burn Bypass Valve Closed (E)	142.66	(B) + 5 min.
First Burn Bypass Valve Open (H)	92.47	(E) - 10 max.
Step Pressure Valve Open (I)	46.64	(H) - 5 max.

4.2.30.1 (Continued)

Section 5, J-2 Engine System Test

Function	Measured Value	Limits
Engine Ignition Bus Voltage (vdc)	28.18	27 ±3
Engine Control Bus Voltage (vdc)	28.31	27 ±3
Component Test Power Voltage (vdc)	28.20	27 ±3
Start Tank Pressure (psia)	52.91	40 min.
Engine Ignition Timer Delay (sec.)	0.430	0.45 ±0.03
Helium Delay Timer (sec.)	0.994	1.0 ±0.11
Sparks De-energize Timer (sec.)	3.288	3.3 ±0.20
Start Tank Discharge Timer (sec.)	1.011	1.00 ±0.04

Mainstage OK Pressure Switches Check

Function	Measured Value (psia)			Limits (psia)
	Test 1	Test 2	Test 3	
Stage 6 Line Pressure	562.75	559.56	560.61	600 ±50
Stage 6 Dome Pressure	568.06	562.75	565.94	
Mainstage OK PS 1 Pickup	517.52	515.17	515.17	515 ±36
Mainstage OK PS 1 Dropout	455.80	455.80	456.59	PU-62.5 ±43.5
Stage 2 Line Pressure	584.56	584.56	580.83	600 ±50
Stage 2 Dome Pressure	606.91	610.63	603.17	
Mainstage OK PS 2 Pickup	516.61	514.30	514.30	515 ±36
Mainstage OK PS 2 Dropout	447.62	446.06	448.39	PU-62.5 ±43.5

Control Solenoid Valves Check

Function	AO Multiplexer	BO Multiplexer	Limit
Regulator Output Press. (psia)	427.70	429.23	440 max.

	Measured Position (%)	Limit (%)
Main LH_2 Valve Closed	9.70	10 ±10
Main LH_2 Valve Open	86.70	90 ±10
Main LH_2 Valve Reclosed	9.90	Closed ±2
Start Tank Disch. Valve Closed	13.10	10 ±10
Start Tank Disch. Valve Open	93.80	90 ±10
Start Tank Disch. Valve Reclosed	13.30	Closed ±2
Gas Generator Valve Closed	9.80	10 ±10

4.2.30.1 (Continued)

	Measured Position (%)	Limit(%)
Gas Generator Valve Open	88.70	90 ±10
Gas Generator Valve Plateau	45.20	65 max.
Gas Generator Valve Reclosed	9.80	Closed ±2
Main LOX Valve Closed	11.40	10 ±10
Main LOX Valve 1st Ramp	24.60	
Main LOX Valve Open	91.90	90 ±10
Main LOX Valve Reclosed	11.40	Closed ±2
LOX Turbine Bypass Valve Open	89.40	90 ±10
LOX Turbine Bypass Valve Closed	9.20	10 ±10
LOX Turbine Bypass Valve Reopened	89.50	Open ±2

Engine Sequence Check

Function	Start Time (sec.)	Oper. Time (sec.)	Total Time (sec.)
Ignition Phase Solenoid Talkback	-	0.011	-
Control He Solenoid Talkback	-	0.017	-
ASI LOX Valve Open	-	0.045	-
Main LH_2 Valve Open	0.076	0.058	0.134
LOX Bleed Valve Closed	-	0.062	-
LH_2 Bleed Valve Closed	-	0.069	-
Start Tank Disch. Timer	-	1.001	-
Start Tank Disch. Valve Open	0.100	0.107	0.207
Mainstage Control Solenoid Energ.	-	1.452	-
Ignition Phase Timer	-	0.451	-
Start Tank Disch. Control Sol. Off	-	0.007	-
Main LOX Valve 1st Stage Motion	0.053	0.048	0.101
Start Tank Disch. Valve Closed	0.091	0.250	0.341
Gas Gen. Valve LOX Poppet	0.130	0.064	0.126
LOX Turbine Bypass Valve Close	0.203	0.253	0.456
Main LOX Valve 2nd Stage Motion	0.647	1.810	2.457
Spark System Off Timer	-	3.297	-
Ignition Phase Control Sol. Off	-	0.007	-
Mainstage Control Solenoid Off	-	0.033	-
ASI LOX Valve Closed	0.026	-	-
Main LOX Valve Closed	0.063	0.132	0.195
Main LH_2 Valve Closed	0.088	0.248	0.320
Gas Generator Valve Closed	0.072	0.224	0.312
LOX Turbine Bypass Valve Open	0.254	0.596	0.850
Control He Sol. De-energ. Timer	-	0.997	-
LOX Bleed Valve Open	9.885	-	-
LH_2 Bleed Valve Open	11.058	-	-

4.2.31 Range Safety System (1B59482 E)

The automatic checkout of the range safety system verified the system external/internal power transfer capability; and the capability of the system to respond to the propellant dispersion inhibit and trigger commands, the engine cutoff command, and the system off command. The items involved in this test included the following:

Part Name	Reference Location	P/N	S/N
Range Safety Receiver 1	411A97A14	50M10697	107
Range Safety Receiver 2	411A97A18	50M10697	108
Secure Command Decoder 1	411A99A1	50M10698	102
Secure Command Decoder 2	411A99A2	50M10698	21
Secure Command Controller 1	411A97A13	1B33084-503	9
Secure Command Controller 2	411A97A19	1B33084-503	10
RS System 1 EBW Firing Unit	411A99A12	40M39515-119	532
RS System 2 EBW Firing Unit	411A99A20	40M39515-119	534
RS System 1 EBW Pulse Sensor	411A99A31*	40M02852	470
RS System 2 EBW Pulse Sensor	411A99A32*	40M02852	487
Safe and Arm Device	411A99A22*	1A02446-503	51
Directional Power Divider	411A97A56	1B38999-1	44
Hybrid Power Divider	411A97A34	1A74778-501	33
*Installed in Pulse Sensor Assembly	411A99A31/A32	1B29054-501	17

Initiated on 24 August 1967, the procedure was completed by the seventh attempt on 28 August 1967 after 3 days of activity, and was accepted on 30 August 1967. Of the first six attempts, several were not acceptable because of program problems and out-of-tolerance readings, while others were engineering runs only. The program problems involved the loading of program segment 0, while the out-of-tolerance readings were caused by excessive delay times. Procedure revisions were made to correct these problems. The engineering runs were made to obtain EBW firing unit charging voltage data, and to verify that the delay time change was satisfactory. The following narration and Test Data Table 4.2.31.1 cover the satisfactory seventh attempt.

Initial conditions were established for the test, and the GSE Model DSV-4B-136 destruct system test set, P/N 1A59952-1, was set up for closed loop operation at 450 MHz with a -50 dbm output level and a 60 kHz deviation. The forward

4.2.31 (Continued)

bus 1 and bus 2 battery simulators were turned on, both receivers were verified to be OFF, and the battery simulator voltages were measured.

The external/internal power transfer test was then started. Both EBW firing units were verified to be OFF, and external power was turned on for both receivers and both firing units. The cutoff destruct indications, the firing unit charging voltage indications, and the firing unit indications, were measured for both range safety systems. The propellant dispersion cutoff command inhibit was then turned on for both receivers. Both firing units were transferred to internal power, and the external power for the units was turned off. Both units were verified to be ON, and the charging voltage indications were measured. Both firing units were transferred back to external power and verified to be OFF, and the firing unit charging voltage indications were again measured. The external power for both receivers was turned off, and the receivers were verified to be OFF. The receivers were transferred to internal power and verified to be ON, then transferred back to external power and verified to be OFF. Finally, both receivers were transferred back to internal power and again verified to be ON.

The EBW firing unit arm and engine cutoff test was conducted next. The engine control bus power was turned on, the bus voltage was measured, and the low level signal strength indications were measured for both receivers. The EBW firing unit arm and engine cutoff command was turned on and verified to be received by range safety system 1. The system 1 firing unit charging voltage indication was measured. Verification was made that the engine cutoff indications were OFF at the umbilical and through the AO and BO telemetry multiplexers; that the non-programmed engine cutoff indication was OFF; and that the instrument unit receiver 1 arm and engine cutoff indication was OFF. The receiver 1 propellant dispersion cutoff command inhibit was then turned off, and the instrument unit receiver 2 arm and engine cutoff indication was verified to be OFF. Verification was made that the engine control bus power was then OFF; that the engine cutoff indications were still OFF at the umbilical and through both multiplexers; that the

4.2.31 (Continued)

non-programmed engine cutoff indication was still OFF; and that the instrument unit receiver 1 arm and engine cutoff indication was then ON. The receiver 1 propellant dispersion cutoff command inhibit was turned back on, and the instrument unit receiver 1 arm and engine cutoff indication was verified to again be OFF. The EBW firing unit arm and engine cutoff command was turned off, turned back on while the system 1 cutoff destruct indication voltage was measured, and then turned off again. The engine control bus power was turned back on and the bus voltage was measured. Both firing units were transferred to external power and verified to be OFF, and the charging voltage indications were measured.

The EBW firing unit arm and engine cutoff command was turned back on and verified to be received by range safety system 2. The system 2 firing unit charging voltage indication was measured. Verification was made that the engine cutoff indications were OFF at the umbilical and through the AO and BO telemetry multiplexers; that the non-programmed engine cutoff indication was OFF; and that the instrument unit receiver 2 arm and engine cutoff indication was OFF. The receiver 2 propellant dispersion cutoff command inhibit was turned off, and the instrument unit receiver 1 arm and engine cutoff indication was verified to be OFF. Verification was made that the engine control bus power was still ON; that the engine cutoff indication was then ON at the umbilical and through both multiplexers; that the non-programmed engine cutoff indication was then ON; and that the instrument unit receiver 2 arm and engine cutoff indication was ON. The receiver 2 propellant dispersion cutoff command inhibit was turned back on, and the instrument unit receiver 2 arm and engine cutoff indication was verified to again be OFF. The EBW firing unit arm and engine cutoff command was turned off, turned back on while the system 2 cutoff destruct indication voltage was measured, and then turned off. The engine ready bypass was turned on, and the engine cutoff indication was verified to be OFF at the umbilical.

4.2.31 (Continued)

The EBW pulse sensor power and the pulse sensor self test were turned on and both range safety pulse sensors were verified to be SET. The pulse sensor reset was turned on, and both pulse sensors were verified to be RESET. Each of the range safety systems was individually tested by the following steps, starting with system 1. The propellant dispersion command was turned on and verified to be received by the receiver under test. The appropriate firing unit charging voltage indication was measured, and the appropriate pulse sensor was verified to be OFF. The propellant dispersion command was turned off, the propellant dispersion cutoff command inhibit for the receiver under test was turned off, and the propellant dispersion command was turned back on. For the system under test, the firing unit charging voltage was measured, and the pulse sensor was verified to be ON. The propellant dispersion cutoff command inhibit was then turned back on. The propellant dispersion command was turned off, turned back on while the cutoff destruct indication was measured, and then turned off again. The above steps were then repeated to test system 2. After the test of system 2, the propellant dispersion cutoff command inhibit was turned off for both receivers, and the engine control bus power was verified to be OFF.

The range safety system off test was conducted next. The range safety system off command was turned on, and power for receiver 1 and the system 1 EBW firing unit was verified to be OFF. The range safety system off command was turned off, receiver 2 was transferred to internal power, the range safety system off command was turned back on, and the power for receiver 2 and the system 2 EBW firing unit was verified to be OFF. The range safety system off command was turned back off, and the cutoff destruct indications were measured for both systems.

4.2.31 (Continued)

The safe and arm device was tested next. The safe-arm safe command was turned on, the safe indication was verified to be ON, and the arm indication was verified to be OFF. The safe-arm arm command was turned on, the safe indication was verified to be OFF, and the arm indication was verified to be ON. The safe-arm safe command was turned back on, and again the safe indication was verified to be ON, and the arm indication was verified to be OFF.

This completed the range safety system tests, and the shutdown operations were accomplished. The computer printout indicated that each of the two range safety receivers and two secure decoders had accumulated 1 minute 13.468 seconds of running time during the procedure, each of the range safety EBW firing units had undergone 1 on-off cycle, and the switch selector had been used 1 time.

Engineering comments noted that there were no parts shortages affecting this test. As noted, the only problems encountered during this test were with the program, and no FARR's were written. Four revisions were made to the procedure:

a. One revision added a step to the destruct system test set manual setup instructions to verify that no commands or tones were turned on. This was to agree with the test requirements drawing, 1B64704.

b. One revision deleted four printout statements from the pulse sensor self-test subroutine, to avoid contradictory printouts if a malfunction occurred. The statements would have indicated that the pulse sensors were properly set or reset, even if a malfunction printout indicated that they were not.

c. One revision added a breakpoint and the COAL statements required to initiate segment 0 of the program, to establish initial conditions. The identification control card for segment 0 was omitted when the last change of the program was compiled.

d. One revision changed delay times from 8 milliseconds to be 2 milliseconds at four places in the program where the cutoff destruct indications were measured. The 8 millisecond delay allowed malfunction indications to be made in error. Reducing the delay times corrected the problem, but a suggested permanent correction was to check for peak voltage, rather than after a fixed delay.

4.2.31.1 Test Data Table, Range Safety System

Function	Measured Value (vdc)	Limits (vdc)
Forward Bus 1 Battery Simulator	28.239	28.0 ±2.0
Forward Bus 2 Battery Simulator	28.438	28.0 ±2.0
External/Internal Power Transfer Test		
External Power On		
System 1 Cutoff Destruct Indication	1.14	1.28 ±0.3
System 1 Charging Voltage Indication	4.265	4.2 ±0.3
System 1 Firing Unit Indication	4.240	4.2 ±0.3
System 2 Cutoff Destruct Indication	1.14	1.28 ±0.3
System 2 Charging Voltage Indication	4.279	4.2 ±0.3
System 2 Firing Unit Indication	4.256	4.2 ±0.3
Internal Power		
System 1 Charging Voltage Indication	4.270	4.2 ±0.3
System 2 Charging Voltage Indication	4.274	4.2 ±0.3
External Power Off		
System 1 Charging Voltage Indication	0.050	0.3 max.
System 2 Charging Voltage Indication	0.045	0.3 max.
Firing Unit Arm and Engine Cutoff Test		
Engine Control Bus Voltage	28.275	28.0 ±2.0
Receiver 1 Signal Strength Indication	3.559	3.75 ±1.25
Receiver 2 Signal Strength Indication	3.563	3.75 ±1.25
System 1 Arm and Engine Cutoff Test		
Firing Unit Charging Voltage Indication	4.255	4.2 ±0.3
Cutoff Destruct Indication	2.21	2.43 ±0.3
Engine Control Bus Voltage	28.31	28.0 ±2.0
External Power Off		
System 1 Charging Voltage Indication	0.050	0.3 max.
System 2 Charging Voltage Indication	0.045	0.3 max.
System 2 Arm and Engine Cutoff Test		
Firing Unit Charging Voltage Indication	4.274	4.2 ±0.3
Cutoff Destruct Indication	2.22	2.43 ±0.3

4.2.31.1 (Continued)

Function

Propellant Dispersion Test	Measured Value (vdc)	Limits (vdc)
System 1 Propellant Dispersion Test		
Charging Voltage Indication (Pulse Sensor OFF)	4.265	4.2 ±0.3
Charging Voltage Indication (Pulse Sensor ON)	1.704	3.0 max.
Cutoff Destruct Indication	2.948	3.16 ±0.3
System 2 Propellant Dispersion Test		
Charging Voltage Indication (Pulse Sensor OFF)	4.284	4.2 ±0.3
Charging Voltage Indication (Pulse Sensor ON)	1.555	3.0 max.
Cutoff Destruct Indication	2.964	3.16 ±0.3
Range Safety System Off Test		
System 1 Cutoff Destruct Indication	0.000	0.0 ±0.3
System 2 Cutoff Destruct Indication	-0.005	0.0 ±0.3

4.2.32 All Systems Test (1B65533 C)

After all individual system checkouts were completed, the all systems test demonstrated the combined operation of the stage electrical, hydraulic, propulsion, instrumentation, and telemetry systems under simulated flight conditions. Where practical, the checkout followed the actual flight sequence of prelaunch operations, simulated liftoff, ullage firing, engine start, hydraulic gimbaling, engine cutoff, coast period, attitude control, and stage shutdown. The procedure was conducted twice, once for the umbilicals-in test, and again for the umbilicals-out test. During the umbilicals-in test, the umbilical cables were left connected during the entire procedure, to permit monitoring of the umbilical talkbacks, and to provide complete stage control for trouble shooting and safing operations. During the umbilicals-out test, the umbilical cables were ejected at simulated liftoff, to verify the proper operation of all on-board systems with the umbilicals disconnected. After the completion of the all systems test, the umbilicals were reconnected, and the stage was shut down and completely reset to the proper condition for subsequent shipment to STC.

4.2.32 (Continued)

The all systems test was initiated on 5 September 1967, and was active for 3 days. The first attempt was a preliminary test with the umbilicals in, to identify and resolve any problems. The umbilicals-in part of the test was completed by the second attempt on 6 September 1967, while the umbilicals-out part of the test was completed by the third attempt on the same date. After some trouble shooting activity on 8 September 1967, the procedure was accepted following the test data review meetings on 7, 8, and 13 September 1967.

The various measurements made during the acceptable umbilicals-in and umbilicals-out tests are presented in Test Data Table 4.2.32.1. All of these measurements were acceptable and within design requirements, unless otherwise noted, although specific test limits were not defined by the procedure for some of the measurements.

Prior to starting the all systems automatic procedure, the GSE electrical systems and the stage propulsion system were manually set up for the test, and the stage power setup procedure, H&CO 1B59590, was accomplished. Initial conditions were then established, and the stage power setup test was conducted. During this test, power was applied to the propellant utilization inverter and electronics, the EBW pulse sensors, the engine control and ignition buses, the APS buses, and aft bus 2, while various currents and voltages were measured. The EBW ullage rocket firing unit disable command, and the propellant dispersion cutoff command inhibits for both range safety receivers, were also turned on. The proper operation of the switch selector was verified during the umbilicals-in test only.

The manual setup of the propulsion system was verified, the propulsion system initial conditions were established, and the various helium supply pressures were measured. The LOX chilldown pump purge and engine pump purge sequences were then accomplished.

The next series of prelaunch checks verified that the LOX and LH_2 vent valves and fill and drain valves opened properly on command, and that the LOX and LH_2 point level sensors, fast fill sensors, and overfill sensors all responded properly to simulated wet conditions. The simulated wet conditions were left on

4.2.32 (Continued)

for all except the overfill sensors, to simulate loaded propellant tanks. The proper operation of the LOX and LH_2 chilldown shutoff valves, prevalves, and vent valves was verified, and the LOX and LH_2 tank prepressurization sequences were accomplished. The LH_2 tank pressure control module pressure was measured during the last sequence. The LOX and LH_2 fill and drain valves were then closed, the proper operation of the LH_2 directional vent valve was verified, and the valve was set to the ground position.

The EBW and telemetry prelaunch checks were conducted next. A pulse sensor self test verified the proper operation of the ullage rocket and range safety EBW firing unit pulse sensors. The PCM RF assembly was then turned on and the current was measured. During the umbilicals-in test only, measurements of the PCM transmitter output power verfied that the telemetry RF silence command properly turned off the PCM RF assembly. During both tests, a telemetry calibration and a RACS calibration were then accomplished. The PCM transmitter output power was measured as the telemetry antenna 1 forward power, the telemetry RF system reflected power was measured, and the telemetry system closed loop VSWR was determined. Measurements were also made of the static inverter-converter output voltages and operating frequency. During the umbilicals-in test only, the engine cutoff and the nonprogrammed engine cutoff indications were both verified to be OFF. During the umbilicals-out test only, the engine cutoff command was turned on and only the nonprogrammed engine cutoff indication was verified to be OFF.

The hydraulic system prelaunch checks were conducted next. The pitch and yaw actuator locks were removed, the hydraulic reservoir gaseous nitrogen mass and corrected oil level were measured, and the hydraulic system functions were measured with the hydraulic system unpressurized. The auxiliary hydraulic pump was then turned on to pressurize the system, the system pressure increase over a 4 second period was measured, and the hydraulic system functions were remeasured with the system pressurized.

A flow rate and turbine speed (FRATS) calibration was accomplished next. For this check, a 400 Hz calibration frequency was supplied by the GSE while the indication voltages were measured for the LOX and LH_2 circulation pump flowrates

4.2.32 (Continued)

and the static inverter-converter frequency; a 100 Hz calibration frequency was supplied while the LOX and LH_2 flowmeter indication voltages were measured; and a 1500 Hz calibration frequency was supplied while the LOX and LH_2 pump speed indication voltages were measured. The LOX and LH_2 chilldown inverter checks were accomplished next. The chilldown pumps were turned on, the pump currents were measured, the aft bus 2 voltage was measured, and the inverter phase voltages were measured through the hardwire monitors. The operating frequency of each inverter was manually verified to be 400 ± 4 Hz through the hardwire monitors.

The stage and GSE were then set for open loop telemetry operation by turning on the RF distribution system 2 and setting the PCM ground station for open loop reception. A series of checks measured the common bulkhead and LH_2 tank ullage pressures, their 20 and 80 percent calibration voltages, the ambient pressure after each calibration, and the LOX tank ullage pressure. For a telemetry system open loop RF check, the PCM transmitter output power was measured as the telemetry antenna 1 forward power, the telemetry RF system reflected power was measured, and the system open loop VSWR was determined. The rate gyro was then turned on, and a telemetry calibration and a RACS calibration were performed.

The final prelaunch checks were started next. During the umbilicals-in test, the battery simulators were turned on, and measurements were made of the battery simulator voltages and the electrical support equipment load bank voltages. During the umbilicals-out test, the checkout batteries were turned on, and the checkout battery voltages were measured. The transducers for the common bulkhead pressure and the LH_2 and LOX tank ullage pressures were all turned off, and the transducer output voltages were measured. The LH_2 and LOX fast fill sensor simulated wet conditions were then turned off.

The forward and aft buses were transferred to internal power, and the bus voltages were measured. Both range safety receivers were transferred to internal power, and their low level signal strength indications were measured. The EBW ullage rocket firing unit disable command was turned off, the range safety system safe and arm device was set to the ARM condition, the DDAS antenna input

was turned on, and the propellant dispersion cutoff command inhibit was turned off for both range safety receivers. It was verified that the open loop PCM RF signal was being received at the PCM and DDAS ground stations. The cold helium supply shutoff valve was then opened. For the umbilicals-out test only, the external power was turned off for the forward and aft power buses and the talkback bus, the aft and forward umbilicals were ejected and visually verified to be disconnected, and the local sense indications were verified to be ON. For the umbilicals-in test only, the external powers were left on, it was verified that the umbilicals remained connected, and the local sense indications were verified to be OFF. The emergency detection system transducer and ullage pressures were then measured for both tests. This completed the prelaunch checks with the simulated liftoff.

Following the simulated liftoff, a telemetry calibration was accomplished, and the preseparation checks were conducted. The six ullage rocket ignition EBW firing units were charged. The LH_2 and LOX prevalves were opened and reclosed, and the LH_2 chilldown pump was turned off. The fire ullage ignition command was turned on, and it was verified that the six ullage ignition EBW firing units responded properly and that the ullage ignition pulse sensors were ON. The aft separate simulation 1 and 2 signals were then turned on to simulate stage separation. During the above part of the umbilicals-in test only, additional checks verified that the ullage rocket firing unit disable command prevented the ignition EBW firing units from charging, and discharged the previously charged firing units while preventing them from firing.

APS roll and engine start checks were conducted following the simulated stage separation. The instrument unit (IU) substitute -28 volt power was turned on and measured. For the APS roll checks, attitude control nozzles I IV and III II were turned on and off, and attitude control nozzles I II and III IV were turned on and off, while the APS engine 1-1 1-3 and 2-1 2-3 valve open indications were measured for each condition. The LOX chilldown pump was then turned off, and the LH_2 and LOX chilldown shutoff valves were opened and reclosed. The engine start sequence was then accomplished, the LH_2 injector temperature detector bypass and the LH_2 first burn relay were turned on, and the simulated ignition detected and simulated mainstage OK

4.2.32 (Continued)

indications were turned on to simulate a satisfactory engine start. The two ullage rocket jettison EBW firing units were charged, the fire ullage jettison command was turned on, and it was verified that both ullage jettison firing units responded properly and that the ullage jettison pulse sensors were ON. During this part of the umbilicals-in test only, additional checks verified that the ullage rocket firing unit disable command prevented the jettison EBW firing units from charging, and discharged the previously charged firing units while preventing them from firing.

Following the engine start sequence, the hydraulic gimbal and propellant utilization valve slew checks were conducted, starting with the step response gimbal and LOX valve slew checks. The propellant utilization system ratio valve position indication and the hydraulic system pressure were both measured, and the LOX bridge 1/3 checkout relay was turned on. A series of step response gimbal checks were conducted for 0 to -3 degrees, -3 to 0 degrees, 0 to +3 degrees, and +3 to 0 degrees, in both the pitch and yaw planes. As the results of these checks were compatible with the results of the same checks during the hydraulic system automatic checkout, H&CO 1B59485, (reference paragraph 4.2.28), the measured data is not repeated. Following the gimbal sequence, the propellant utilization system ratio valve position indication was again measured, and the LOX 1/3 checkout relay was turned off. A 0.6 Hz gimbal and LH_2 propellant utilization valve slew check was conducted next. The propellant utilization system ratio valve position indication and the hydraulic pressure were measured, and the LH_2 bridge 1/3 checkout relay was turned on. A 0.5 degree gimbal signal, at 0.6 Hz, was applied in the pitch and yaw planes. The engine position command currents and the resulting actuator piston positions were within the required limits throughout the cycling in both planes, for both the umbilicals-in and umbilicals-out tests. At the completion of the gimbal sequences, the hydraulic actuator piston positions and the engine pitch and yaw positions were measured, and the hydraulic system functions were measured with the hydraulic system pressurized. The propellant utilization system ratio valve position indication was then measured, the LH_2 bridge 1/3 checkout relay was turned off, and the ratio valve position indication was remeasured.

4.2.32 (Continued)

The first burn and coast period sequences were conducted next. During the first burn pressurization, the LOX and LH_2 pressurization control module helium gas pressures and the cold helium control valve inlet pressure were measured while the helium supply valves were temporarily opened, and again after the pressure switch supplies were closed and the flight control pressure switches were verified to be OFF. The LH_2 first burn relay was turned off and the LH_2 pressurization control module pressure was remeasured. The engine cutoff was then accomplished; the LH_2 injector temperature detector bypass, the LOX flight pressurization system, and the simulated ignition detected signal were all turned off; and the auxiliary hydraulic pump was set for coast mode operation.

A series of checks verified that a dry condition of any one LOX or LH_2 point level sensor would not cause engine cutoff, but that a dry condition of any two LOX sensors or any two LH_2 sensors would cause engine cutoff. The sensors were checked by turning off the simulated wet conditions for the combinations of LOX and LH_2 sensors. During the umbilicals-in test only, the operation time of the LOX depletion engine cutoff timer was measured for each combination of LOX sensors.

The emergency detection system and range safety system tests were conducted next. Verification was made that each of the emergency detection system 1 and 2 engine cutoff commands properly caused engine cutoff. A series of checks then verified that the range safety EBW firing unit arm and engine cutoff command properly charged the range safety firing units and caused engine cutoff, and that the range safety propellant dispersion command properly fired the range safety EBW firing units. During the umbilicals-in test only, additional checks verified that the range safety receiver 1 and 2 propellant dispersion cutoff command inhibits properly prevented engine cutoff and EBW firing unit operation. The coast period command was turned on, and the propellant utilization inverter and electronics power was turned off. As a final range safety system test, it was verified that the range safety system off command properly turned off both range safety receivers.

4.2.32 (Continued)

A series of APS pitch and yaw attitude control checks were conducted next. For the pitch checks, the APS attitude control nozzles I P and III P were individually turned on and off while the APS engine 1-2 and 2-2 valve open indications were individually measured for each condition. For the yaw checks, the APS attitude control nozzles I IV and III IV were turned on and off, and the attitude control nozzles I II and III II were turned on and off, while the engine 1-1 1-3 and 2-1 2-3 valve open indications were measured for each condition. A final telemetry calibration was accomplished, and the stage shutdown was accomplished to complete the all systems test.

The computer printout showed that during the umbilicals-in test, the auxiliary hydraulic pump accumulated 2 cycles and 6 minutes 55.2 seconds of running time; the J-2 engine accumulated 1 cycle at 3 degrees amplitude in the pitch and yaw gimbal planes; the range safety system running time was 15 minutes 46.5 seconds; each of the ullage and range safety EBW firing units was cycled 1 time; the propellant utilization LOX and LH_2 bridge potentiometers were each cycled 1 time; and the switch selector was used 98 times. During the umbilicals-out test, the auxiliary hydraulic pump accumulated 1 cycle and 27 minutes 15.7 seconds of running time; the J-2 engine accumulated 1 cycle at 3 degrees amplitude in the pitch and yaw gimbal planes; the range safety system running time was 17 minutes 24.6 seconds; each of the ullage and range safety EBW firing units was cycled 1 time; the propellant utilization LOX and LH_2 bridge potentiometers were each cycled 1 time; and the switch selector was used 89 times.

Engineering comments noted that three temperature transducers, P/N's NA5-27323T3, were not installed on the J-2 engine at the start of the test. These transducers were for measurement C1, the fuel turbine inlet temperature, 4013MTT18; measurement C2, the oxidizer turbine inlet temperature, 4013MTT19; and measurement C215, the oxidizer turbine outlet temperature, 4013MTT20. The interim use transducers installed for these measurements were to be replaced by flight use items before static firing at STC. Three engine pressure transducers were also listed as shortages. These were for measurement D1, the thrust chamber pressure, transducer 4013MTP3, P/N NA5-27412T10T; measurement

4.2.32 (Continued)

D17, the GH_2 start bottle pressure, transducer 4013MTP5, P/N NA5-27412T15T; and measurement D18, the engine regulator outlet pressure, transducer 4014MTP52, P/N NA5-27412T7LT. As noted in paragraph 4.2.18, these transducers were rejected during the DDAS automatic checkout, H&CO 1B59594, for out-of-tolerance operation. As replacement transducers were not available at that time, the defective transducers were retained for use during the all systems test, with new units subsequently installed and tested by the DDAS procedure.

Engineering comments also noted several problems encountered during the test:

a. Channel calibration command decoder 404A72A200 had an output on all channels when a high or low RACS test command was applied to channel 19 of decoder 404A63A614. After the completion of the all systems test, the defective decoder was rejected by FARR A261325 and a new unit was installed and checked for this type of malfunction. The new unit was then tested and accepted by the final attempt of the DDAS procedure, H&CO 1B59594, as noted in paragraph 4.2.18.

b. During the umbilicals-out test, the low level signal strength of both range safety receivers varied erratically for about 5 minutes after the umbilicals were ejected. Nearly identical variations indicated that the problem was probably with the stage or GSE antennas, the GSE destruct system test set, or external RF noise. Subsequent to the all systems test, extensive trouble shooting over a 4 hour period could not duplicate the condition, and the problem was attributed to unidentified RF interference.

c. Due to the omission of a revision from the umbilicals-in test, incorrect values were printed out for the telemetry system open loop reflected power and VSWR. The correct values, as provided by Engineering, are shown in the Test Data Table.

Two FARR's were written during this procedure:

a. FARR A261325 rejected channel decoder assembly 404A72A200, P/N 1A74053-503, S/N 233, for having an output on all channels during the high and low RACS test 5 of channel 19. There should have been no output on any channel. A new decoder, S/N 331, was installed, tested during the final DDAS procedure test, and accepted for use.

b. FARR A271226 noted that twelve measurements exceeded the noise level tolerance of 2 to 5 percent for not over 1 second duration. Measurements D1, D10, D18, and M69 were affected by chilldown inverter noise, while measurements D16, D54, D160, D184, D218, N18, N55, and D576 (hardwire) were affected by RFI. These conditions were accepted by the data review meeting, although disposition of the FARR was still pending at the time of stage storage.

4.2.32 (Continued)

Thirty-three revisions were made to the procedure:

a. One revision changed the setup and measurement for the umbilical LOX ullage pressure, measurement D577, to conform to the normal transducer setup and use. The LOX isolation hand valve was to be opened rather than closed, and the pressure measurement was to be 49 ±4 psia rather than 14.7 ±1 psia at one point.

b. One revision added a step to close the start tank vent valve prior to the engine start, for personnel safety.

c. One revision changed the umbilical ejection method to reduce the time the GSE stage 6 was at a high pressure, to avoid SIM interrupts. Rather than pressurizing stage 6 to 750 ±25 psia during the test setup, the pressure was maintained at 150 ±50 psia until just before umbilical ejection, then manually increased to 750 ±25 psia. After ejection, the pressure was reduced to 150 ±50 psia.

d. One revision, for use at SSC only, deleted the steps to turn off the Model 127 tape recorder after the hydraulic system prelaunch checks, to reload the recorder, and to turn it back on before the FRATS calibration, as the tape recorder was not to be reloaded until after recorder transfer had occurred.

e. One revision corrected procedure errors and omissions. A special cable installation reference drawing number was corrected to be 1B66461-507, rather than -505; the Model DSV-4B-268 aft interface substitute unit, P/N 1A89815-1, was added to the Mandatory End Item Equipment list; and a note was added to the Running Time/Cycle Record paragraph to indicate that the switch selector accumulated cycles would be available as a computer typewriter output at the end of the test.

f. Two revisions changed the LH_2 and LOX chilldown inverter hardwire measurements. The voltage measurement tolerances were changed to be +2, -4.5 vdc rather than ±3 vdc, because of the voltage drop in the GSE cables and the noise spikes that were present when the voltage monitoring circuit was not loaded with a multiplexer. The automatic inverter frequency measurements were deleted, and instructions were added to manually measure the frequencies, as the automatic capability in the GSE Model 131 was not functioning.

g. Two revisions corrected minor procedure and program errors.

h. One revision changed the LOX chilldown pump purge operation slightly to allow for an increased pressure rise rate due to the module bypass purge.

i. Six revisions added steps at nine places in the program to verify the proper ON or OFF condition of nine functions: measurements K1, K2, K16, K17, K113, K114, K131, K151, and the engine control bus power.

j. One revision corrected the GSE Digital Signal Synchronizer setup to set the loop bandwidth switch to the 0.005 percent position rather than the 0.08 percent position if the VCO mode was used, to provide the narrowest bandwidth setting with no loss of synchronization.

4.2.32 (Continued)

k. One revision deleted a GSE setup step to verify that the receiver was turned off in the DDAS ground station that was not being used, as the on or off state of this equipment did not affect the test.

l. One revision modified the emergency stop routine to include the propulsion system requirements.

m. One revision changed the tolerance limits for SIM channels 34, 35, 44, and 46, to be compatible with new requirements for these channels.

n. One revision added a step to verify that the DDAS ground station was in synchronization prior to the initial conditions scan, to correct a procedure omission.

o. One revision corrected one check and a printout statement to verify that reference oscillator system 1, rather than RF distribution system 1, was reset prior to the initial conditions scan. The reset of matrix six affected reference oscillator system 1 and RF distribution system 2, but not RF distribution system 1.

p. Two revisions modified the FRATS calibration to more accurately measure the FRATS circuits. The GSE 400 Hz calibration frequency was manually measured in tenths of a cycle, and the indication voltage limits for the circulation pump flow rates and the static inverter-converter frequency were changed from 3.836 $\pm$0.100 vdc and 2.5 $\pm$0.250 vdc, respectively, to be 3.863 $\pm$0.100 vdc and 2.3 $\pm$0.100 vdc, based upon the measured calibration frequency.

q. One revision corrected four erroneous function numbers at six places in the program, to be DRP 2325 rather than DRP 2673; DRP 2326 rather than DRP 2674; DRP 2445 rather than DRP 2666; and DRP 2446 rather than DRP 2667.

r. One revision corrected the scan A subroutine to verify that measurement C50PIT was less than 190°F, rather than measurement C51ROT, and to printout "pump oil temperature" rather than "reservoir oil temperature" in malfunction printouts involving this measurement.

s. One revision added a breakpoint during the point level sensor engine cutoff checks of the umbilicals-out test only, to delay turning off the LOX point level sensor 1 wet condition until the LOX point level sensor 2 wet condition was settled after being turned on.

t. One revision added a step to the propulsion system manual setup to disconnect the start bottle supply flex hose from aft umbilical disconnect 4, to prevent pressurization of the engine start bottle.

u. Two revisions changed two malfunction subroutine "go to" statements during the ullage rocket firing unit checks, to return to the main program at the proper points to re-establish the firing unit charged conditions.

v. One revision added steps to the manual setup operations to connect power cables 404W7P10 and 404W7P9 to connectors 404A74A1J1 and 404A74A2J1 on the LOX and LH_2 chilldown inverters, and noted that

4.2.32 (Continued)

these cables were to be disconnected, coiled, and stowed at the end of the test. To provide protection for the inverters, these cables were disconnected and stowed during VCL testing, except when the use of the inverters was required.

w. One revision changed the telemetry RF system reflected power measurement N55 to show that two "if" statement conditions were to be less than 3.08 watts rather than less than 2 watts, and to make two reflected power computation constants 3.08 rather than 2. This was to be compatible with the new DDT curve for measurement N55, which had a range of 6.15 watts with a breakpoint at 3.08 watts.

x. One revision increased the tolerances on the umbilical LH_2 ullage pressure measurement D576 to account for RFI during open loop transmission. The ambient pressure limits were to be 14.7 ±2 psia rather than 14.7 ±1 psia, the 20 percent calibration was to be 1 ±0.2 vdc rather than 1 ±0.1 vdc, and the 80 percent calibration was to be 4 ±0.2 vdc rather than 4 ±0.1 vdc.

4.2.32.1 Test Data Table, All Systems Test

Function	Umbil.-In	Umbil.-Out	Limits
Power Setup			
PU Inv. and Elect. Current (amps)	4.1	4.2	5.0 max.
Aft Bus 1 Current (Eng. Cont. Bus On) (amps)	2.60	2.70	2.7 ±3.0
Engine Control Bus Voltage (vdc)	27.94	27.88	28.0 ±2.0
Aft Bus 1 Current (Eng. Ign. Bus On) (amps)	2.70	3.00	2.7 ±3.0
Engine Ignition Bus Voltage (vdc)	27.78	27.78	28.0 ±2.0
Aft Bus 1 Current (APS Bus On) (amps)	2.90	3.00	2.7 ±3.0
Aft Bus 2 Current (amps)	0.20	0.00	5.0 max.
Aft Bus 2 Voltage (vdc)	55.6	55.36	56.0 ±4.0
Propulsion System Setup			
Amb. He Pneu. Sphere Press. D160 (psia)	701.1	697.4	700.0 ±50.0
Cold Helium Sphere Pressure D016 (psia)	694.0	686.4	700.0 ±50.0
Eng. Cont. He Supply Press. D019 (psia)	931.9	921.3	900.0 min.
Cont. He Reg. Discharge Press. D014 (psia)	530.5	530.5	515.0 ±50.0
LH_2 Pressurization Sequence			
LH_2 Press. Control Module GH_2 Press. D104 (psia)	53.19	53.19	50.0 min.

4.2.32.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
EBW and Telemetry Checks			
PCM RF Assembly Current (amps)	4.100	4.399	4.5 ±3.0
PCM Transmitter Output (watts)	14.63	**	10.0 min.
PCM Transmitter Output (watts) (T/M RF Silence On)	-0.15	**	2.0 max.
PCM Transmitter Output (watts)	23.97	**	10.0 min.
T/M Antenna 1 Forward Power (watts)	24.745	24.566	15.0 min.
T/M RF System Reflected Power (watts)	0.239	0.227	3.08 max.
Telemetry System Closed Loop VSWR	1.218	1.212	2.0 max.
Inv.-Conv. 115 vac Output (vac)	114.37	114.37	115.0 ±3.45
Inv.-Conv. 5 vdc Output (vdc)	4.96	4.96	4.8 ±0.3
Inv.-Conv. 21 vdc Output (vdc)	21.80	21.79	21.25 ±1.25
Inv.-Conv. Operating Frequency (Hz)	399.45	399.45	400.0 ±6.0
Hydraulic System Checks			
Reservoir GN_2 Mass (lbs)	1.938	1.941	1.925 ±0.2
Corrected Reservoir Oil Level (%)	96.2	96.5	95.0 min.
Hydraulic System Unpressurized			
Hydraulic System Pressure (psia)	1369.03	1378.84	*
Accumulator GN_2 Pressure (psia)	2378.25	2408.25	*
Accumulator GN_2 Temperature (°F)	71.36	74.88	*
Reservoir Oil Temperature (°F)	74.10	77.63	*
Reservoir Oil Level (%)	88.95	89.83	*
Reservoir Oil Pressure (psia)	75.06	75.06	*
Pump Inlet Oil Temperature (°F)	71.36	77.24	*
T/M Yaw Actuator Position (deg)	1.15	1.13	*
Corrected T/M Yaw Act. Pos. (deg)	1.112	1.097	*
IU Yaw Actuator Position (deg)	1.24	1.20	*
Corrected IU Yaw Act. Pos. (deg)	1.185	1.140	*
T/M Pitch Actuator Position (deg)	-0.16	-0.02	*
Corrected T/M Pitch Act. Pos. (deg)	-0.129	0.012	*
IU Pitch Actuator Position (deg)	-0.27	-0.04	*
Corrected IU Pitch Act. Pos. (deg)	-0.217	0.008	*
IU Substitute 5v Power Supply (vdc)	5.03	5.03	*
Aft 5v Excitation Module (vdc)	5.02	5.02	*
Aft Bus 2 Current (amps)	0.00	-0.20	*
Hydraulic System Pressurized			
Hyd. System 4 Second Press. Change (psia)	288.1	284.8	200.0 min.
Hydraulic System Pressure (psia)	3562.13	3565.38	

* Limits Not Specified

** Measurements Not Applicable

4.2.32.1 (Continued)

Function	Umbil.-In	Umbil-Out	Limits
Accumulator GN_2 Pressure (psia)	3594.81	3594.81	*
Accumulator GN_2 Temperature (°F)	92.14	94.11	*
Reservoir Oil Temperature (°F)	73.70	76.06	*
Reservoir Oil Level (%)	39.40	40.39	*
Reservoir Oil Pressure (psia)	168.02	168.02	*
Pump Inlet Oil Temperature (°F)	72.53	76.06	*
T/M Yaw Actuator Position (deg)	-0.04	-0.04	*
Corrected T/M Yaw Act. Pos. (deg)	-0.067	-0.067	*
IU Yaw Actuator Position (deg)	0.06	0.04	*
Corrected IU Yaw Act. Pos. (deg)	0.016	-0.008	*
T/M Pitch Actuator Position (deg)	0.04	0.03	*
Corrected T/M Pitch Act. Pos. (deg)	0.066	0.051	*
IU Pitch Actuator Position (deg)	-0.04	-0.07	*
Corrected IU Pitch Act. Pos. (deg)	0.000	-0.022	*
IU Substitute 5v Power Supply (vdc)	5.03	5.03	*
Aft 5v Excitation Module (vdc)	5.01	5.01	*
Aft Bus 2 Current (amps)	41.60	43.00	*
FRATS Calibration			
LOX Circ. Pump Flowrate Ind. (vdc)	3.855	3.851	3.863 ±0.100
LH_2 Circ. Pump Flowrate Ind. (vdc)	3.841	3.835	3.863 ±0.100
Static Inv.-Conv. Freq. Ind. (vdc)	2.313	2.333	2.3 ±0.100
LOX Flowmeter Indication (vdc)	1.682	1.682	1.667 ±0.100
LH_2 Flowmeter Indication (vdc)	1.691	1.702	1.667 ±0.100
LOX Pump Speed Indication (vdc)	3.148	3.148	3.125 ±0.100
LH_2 Pump Speed Indication (vdc)	1.261	1.261	1.250 ±0.100
Chilldown Inverter Hardwire Checks			
LOX C/D Pump Current (amps)	20.60	22.00	20.0 ±5.0
Aft Bus 2 Voltage (vdc)	54.64	53.52	*
LOX C/D Inv. Phase AB Volt. (vac)	51.15	50.11	Bus 2 +2.0, -4.5
LOX C/D Inv. Phase AC Volt. (vac)	51.09	49.92	Bus 2 +2.0, -4.5
LOX C/D Inv. Phase A1B1 Volt. (vac)	51.28	50.11	Bus 2 +2.0, -4.5
LOX C/D Inv. Phase A1C1 Volt. (vac)	51.15	50.11	Bus 2 +2.0, -4.5
LH_2 C/D Pump Current (amps)	20.20	21.40	20.0 ±5.0
Aft Bus 2 Voltage (vdc)	54.40	53.12	*
LH_2 C/D Inv. Phase AB Volt. (vac)	50.63	49.46	Bus 2 +2.0, -4.5
LH_2 C/D Inv. Phase AC Volt. (vac)	50.76	49.59	Bus 2 +2.0, -4.5
LH_2 C/D Inv. Phase A1B1 Volt. (vac)	50.70	49.66	Bus 2 +2.0, -4.5
LH_2 C/D Inv. Phase A1C1 Volt. (vac)	50.57	49.59	Bus 2 +2.0, -4.5
Pressure Measurements			
Common Bulkhead Pressure (psia)	14.272	14.404	14.7 ±0.5
Common Bulkhead 20% Calib. (vdc)	1.005	1.005	1.0 ±0.1

* Limits Not Specified

4.2.32.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
Common Bulkhead Amb. Press. (psia)	14.220	14.404	14.7 ±0.5
Common Bulkhead 80% Calib. (vdc)	3.935	3.944	4.0 ±0.1
Common Bulkhead Amb. Press. (psia)	14.272	14.431	14.7 ±0.5
LH_2 Ullage Pressure (psia)	12.765	14.129	14.7 ±2.0
LH_2 Ullage 20% Calib. (vdc)	0.854	0.965	1.0 ±0.2
LH_2 Ullage Amb. Press. (psia)	12.869	14.181	14.7 ±2.0
LH_2 Ullage 80% Calib. (vdc)	3.829	3.949	4.0 ±0.2
LH_2 Ullage Amb. Press. (psia)	12.869	14.129	14.7 ±2.0
LOX Ullage Pressure (psia)	51.227	50.844	49.0 ±4.0
Telemetry Open Loop RF Checks			
T/M Antenna 1 Forward Power (watts)	27.095	26.471	15.0 min.
T/M RF System Reflected Power (watts)	2.156	1.469	3.08 max.
Telemetry System Open Loop VSWR	1.786	1.616	3.0 max.
Final Prelaunch Checks			
Fwd. Bus 1 Batt. Sim. (Bus 4D30) (vdc)	28.32	**	28.0 ±2.0
Fwd. Bus 2 Batt. Sim. (Bus 4D20) (vdc)	28.68	**	28.0 ±2.0
Aft Bus 1 Batt. Sim. (Bus 4D10) (vdc)	28.12	**	28.0 ±2.0
Aft Bus 2 Batt. Sim. (Bus 4D40) (vdc)	54.64	**	56.0 ±4.0
Bus 4D20 ESE Load Bank (vdc)	0.04	**	0.0 ±1.0
Bus 4D40 ESE Load Bank (vdc)	0.08	**	0.0 ±1.0
Bus 4D30 ESE Load Bank (vdc)	0.04	**	0.0 ±1.0
Bus 4D10 ESE Load Bank (vdc)	0.00	**	0.0 ±1.0
Fwd Bus 1 C/O Batt. (Bus 4D30) (vdc)	**	30.08	30.0 ±1.0
Fwd Bus 2 C/O Batt. (Bus 4D20) (vdc)	**	30.08	30.0 ±2.0
Aft Bus 1 C/O Batt. (Bus 4D10) (vdc)	**	29.64	30.0 ±2.0
Aft Bus 2 C/O Batt. (Bus 4D40) (vdc)	**	62.24	60.0 ±4.0
Common Bulkhead Press. Transducer (vdc)	-0.005	0.000	0.0 ±0.350
LH_2 Ullage Pressure Transducer (vdc)	0.000	0.000	0.0 ±0.350
LOX Ullage Pressure Transducer (vdc)	0.000	0.005	0.0 ±0.350
Fwd. Bus 1 Internal (Bus 4D31) (vdc)	28.12	29.68	28.0 ±2.0
Fwd. Bus 2 Internal (Bus 4D21) (vdc)	28.24	28.68	28.0 ±2.0
Aft Bus 1 Internal (Bus 4D11) (vdc)	28.04	29.40	28.0 ±2.0
Aft Bus 2 Internal (Bus 4D41) (vdc)	54.56	58.16	56.0 ±4.0

** Measurement Not Applicable

4.2.32.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
Receiver 1 Low Level Signal (vdc)	3.51	3.48	2.5 min.
Receiver 2 Low Level Signal (vdc)	3.53	3.52	2.5 min.
LH_2 EDS Transducer 1 Pressure (psia)	14.9	14.8	14.7 ±1.0
LH_2 EDS 1 Ullage Pressure (psia)	14.90	14.84	14.7 ±1.0
LH_2 EDS Transducer 2 Pressure (psia)	48.2	48.3	49.0 ±4.0
LH_2 EDS 2 Ullage Pressure (psia)	48.03	48.09	49.0 ±4.0
LOX EDS Transducer 1 Pressure (psia)	14.5	14.6	14.7 ±1.0
LOX EDS 1 Ullage Pressure (psia)	14.60	14.66	14.7 ±1.0
LOX EDS Transducer 2 Pressure (psia)	15.0	15.0	14.7 ±1.0
LOX EDS 2 Ullage Pressure (psia)	14.69	14.81	14.7 ±1.0
APS Roll Checks			
IU Substitute -28 volt Power (vdc)	-29.278	-29.438	-28.0 ±2.0
Attitude Control Nozzles I IV and III II On			
Engine 1-1 1-3 Valve Open Ind. (vdc)	4.097	4.235	4.3 ±0.250
Engine 2-1 2-3 Valve Open Ind. (vdc)	4.025	4.148	4.1 ±0.250
Attitude Control Nozzles I IV and III II Off			
Engine 1-1 1-3 Valve Open Ind. (vdc)	-0.010	-0.005	0.0 ±0.250
Engine 2-1 2-3 Valve Open Ind. (vdc)	-0.021	-0.015	0.0 ±0.250
Attitude Control Nozzles I II and III IV On			
Engine 1-1 1-3 Valve Open Ind. (vdc)	4.087	4.225	4.3 ±0.250
Engine 2-1 2-3 Valve Open Ind. (vdc)	4.010	4.122	4.1 ±0.250
Attitude Control Nozzles I II and III IV Off			
Engine 1-1 1-3 Valve Open Ind. (vdc)	-0.005	-0.015	0.0 ±0.250
Engine 2-1 2-3 Valve Open Ind. (vdc)	-0.015	-0.010	0.0 ±0.250
Hydraulic Gimbal Step Response Check			
Ratio Valve Pos. Ind., (Relay Off) (vdc)	2.64	2.66	2.65 ±0.12
Hydraulic System Pressure (psia)	3562.0	3582.0	3500.0 min.
Ratio Valve Pos. Ind., (Relay On) (vdc)	0.11	0.12	1.0 max.
Hydraulic Gimbal 0.6 Hz Check			
Ratio Valve Pos. Ind. (Relay Off) (vdc)	2.53	2.53	2.65 ±0.12
Hydraulic System Pressure (psia)	3965.0	3569.0	3500.0 min.
Pitch Act. Piston Position, AO (deg)	0.013	-0.018	0.0 ±0.517
Pitch Act. Piston Position, BO (deg)	0.013	-0.002	0.0 ±0.517

4.2.32.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
Yaw Act. Piston Position, AO (deg)	-0.045	-0.013	0.0 ±0.517
Yaw Act. Piston Position, BO (deg)	-0.028	-0.028	0.0 ±0.517
Engine Pitch Position, IU (deg)	-0.089	-0.089	0.0 ±0.517
Engine Yaw Position, IU (deg)	0.044	0.044	0.0 ±0.517
Hydraulic System Pressurized			
Hydraulic System Pressure (psia)	3571.88	3568.63	*
Accumulator GN_2 Pressure (psia)	3605.75	3608.50	*
Accumulator GN_2 Temperature (°F)	78.41	78.80	*
Reservoir Oil Temperature (°F)	85.46	125.62	*
Reservoir Oil Level (%)	37.03	42.26	*
Reservoir Oil Pressure (psia)	171.08	171.52	*
Pump Inlet Oil Temperature (°F)	98.82	135.50	*
T/M Yaw Actuator Position (deg)	-0.03	-0.01	*
Corrected T/M Yaw Act. Pos. (deg)	-0.051	-0.035	*
IU Yaw Actuator Position (deg)	0.06	0.04	*
Corrected IU Yaw Act. Pos. (deg)	0.001	-0.015	*
T/M Pitch Actuator Position (deg)	0.01	-0.00	*
Corrected T/M Pitch Act. Pos. (deg)	0.035	0.021	*
IU Pitch Actuator Position (deg)	-0.09	-0.09	*
Corrected IU Pitch Act. Pos. (deg)	-0.030	-0.030	*
IU Substitute 5v Power Supply (vdc)	5.04	5.04	*
Aft 5v Excitation Module (vdc)	5.01	5.01	*
Aft Bus 2 Current (amps)	41.60	**	*
Aft Checkout Battery 2 Current (amps)	**	42.40	*
Ratio Valve Pos. Ind. (Relay On) (vdc)	4.661	4.661	3.5 min
Ratio Valve Pos. Ind. (Relay Off) (vdc)	2.769	2.769	2.65 ±0.12
First Burn and Coast Period			
LOX Pressurization Module Helium Gas Pressure D105:			
Cold Helium Supply Open (psia)	183.71	183.16	*
LOX Press. Sw. Supply Closed (psia)	105.70	102.97	*
Cold Helium Control Valve Inlet Pressure D225:			
Cold Helium Supply Open (psia)	168.98	167.34	*
LOX Press. Sw. Supply Closed (psia)	66.96	63.15	*
LH_2 Press. Module GH_2 Pressure D104:			
LH_2 Prepress. Supply Open (psia)	175.39	175.39	*
LH_2 Press. Sw. Supply Closed (psia)	99.02	104.47	*
LH2 First Burn Relay Off (psia)	56.46	57.55	*

* Limits Not Specified

** Measurement Not Applicable

4.2.32.1 (Continued)

Function	Umbil.-In	Umbil.-Out	Limits
LOX Depletion ECO Timer Value			
Point Level Sensors 1 and 2 Off (sec)	0.559	**	0.560 ±0.025
Point Level Sensors 1 and 3 Off (sec)	0.559	**	0.560 ±0.025
Point Level Sensors 2 and 3 Off (sec)	0.563	**	0.560 ±0.025
APS Pitch Checks			
Attitude Control Nozzle I P On			
Engine 1-2 Valve Open Ind. (vdc)	4.11	4.22	4.3 ±0.25
Attitude Control Nozzle I P Off			
Engine 1-2 Valve Open Ind. (vdc)	0.00	-0.00	0.25 max.
Attitude Control Nozzle III P On			
Engine 2-2 Valve Open Ind. (vdc)	4.07	4.18	4.1 ±0.25
Attitude Control Nozzle III P Off			
Engine 2-2 Valve Open Ind. (vdc)	-0.01	-0.00	0.25 max.
APS Yaw Checks			
Attitude Control Nozzles I IV and III IV On			
Engine 1-1 1-3 Valve Open Ind. (vdc)	4.128	4.204	4.3 ±0.25
Engine 2-1 2-3 Valve Open Ind. (vdc)	4.035	4.092	4.1 ±0.25
Attitude Control Nozzles I IV and III IV Off			
Engine 1-1 1-3 Valve Open Ind. (vdc)	0.010	-0.005	0.25 max.
Engine 2-1 2-3 Valve Open Ind. (vdc)	0.000	-0.015	0.25 max.
Attitude Control Nozzles I II and III II On			
Engine 1-1 1-3 Valve Open Ind. (vdc)	4.107	4.184	4.3 ±0.25
Engine 2-1 2-3 Valve Open Ind. (vdc)	4.046	4.117	4.1 ±0.25
Attitude Control Nozzles I II and III II Off			
Engine 1-1 1-3 Valve Open Ind. (vdc)	0.010	-0.010	0.25 max.
Engine 2-1 2-3 Valve Open Ind. (vdc)	0.005	-0.010	0.25 max.

** Measurement Not Applicable

4.2.33 Forward Skirt Thermoconditioning System Post-Checkout Procedure (1B62965 A)

This procedure secured the forward skirt thermoconditioning system following VCL automatic checkout activities, and consisted of a system cleanliness check, a drain and dry procedure, a leak check, and preparations for stage shipment to STC. These activities were accomplished on 14 and 15 September 1967, with Engineering review and acceptance occurring on 18 September 1967.

The Model DSV-4B-359 thermoconditioning servicer, P/N 1A78829-1, was verified to be properly set up and connected to the stage thermoconditioning system. A visual inspection verified that there was no leakage within the servicer, at the coolant supply and return hose assemblies, P/N's 1B37641-1 and -501, leading to the stage, or within the stage thermoconditioning system.

The system cleanliness check began with an inspection of the cold plates for open mounting holes and improperly torqued bolts. Coolant was circulated through the system, and 1000 milliliter samples of the water/methanol coolant solution were drawn from the fluid sample pressure valve and the fluid sample return valve, after one pint of fluid had been drawn from each valve to purge the valves of possible impurities. The samples were then analyzed for cleanliness per 1P00093, and were found to be acceptable.

For the drain and dry procedure, the stage thermoconditioning system was purged with gaseous nitrogen for 35 minutes, the remaining coolant fluid was drained from the fluid sample pressure and return valves and the air test valve, and gaseous nitrogen was flowed through the system for another 2-1/2 hours. The system moisture content was then verified to be less than 4430 parts per million of water/methanol vapor, equivalent to a 25°F dewpoint.

The stage thermoconditioning system was then purged with freon gas and pressurized to 32 ±1 psig for a leak check. All system B-nuts and fittings, manifold weld areas, panel inlet and outlet boss welds, and manifold flexible bellows were leak checked using a gaseous leak detector, P/N 1B37134-1, with the sensitivity switch set to 1 on the R12-OZ/YR scale. No leaks were found in any of these areas.

4.2.33 (Continued)

The thermoconditioning system was then purged with gaseous nitrogen, and the system dewpoint was again verified to be 25°F or less. The system was then depressurized; the GSE servicer was shut down, disconnected from the stage, and secured, and the stage thermoconditioning system was secured and sealed for subsequent stage shipment.

Engineering comments noted that there were no parts shortages affecting this test. No problems were encountered during the test, and no FARR's were written. One revision was made to the procedure, to disconnect the flow restrictor hose assembly from the load valve and coupler, and to connect the air test valve to the coupler. The flow restrictor was not required for the drain and dry procedure, and it retained moisture and prevented drying of the system. Additional changes to the procedure were made by variation SEO-001A, to ensure that the R12 freon bottle would be disconnected from the servicer except when freon gas was being used. This was to prevent overpressurization of the freon bottle by gaseous nitrogen in case a check valve failed while the shutoff valve was open.

4.3 Propellant Tank System Leak Check (1B65763)

Following the removal of the stage from the VCL checkout tower on 18 September 1967, and prior to the final inspection operations, a leak check was performed to verify the leak-free condition of the stage propellant tank system.

With the stage installed in VCL tower 8, preliminary hookups and installations were accomplished on 25 September 1967. The leak check was initiated on the same date, using production acceptance test A659-1B65763-1PATP6, and was completed and accepted on 27 September 1967. Helium gas was used to pressurize the propellant tank system, and a USON leak detector, leak test bubble fluid, and a Rocketdyne flowmeter were used as required to detect any leakage.

After it was verified that the stage LOX and LH_2 vent and drain valves operated properly under GSE control, a preliminary leak test was accomplished on the

4.3 (Continued)

LOX and LH_2 tank production test equipment (PTE) adapters and fittings. The LOX tank was pressurized to 3.7 psig, and the LH_2 tank was pressurized to 3.5 psig for these checks.

The LOX and LH_2 tanks were then pressurized to 12.1 psig each for an integrity check. After 10 minutes, the LOX tank pressure was remeasured as 11.8 psig, while the LH_2 tank pressure was remeasured as 11.7 psig, both acceptable as verification of tank integrity. Both tanks were then vented to 2.5 psig. The LOX and LH_2 tanks were then purged, repressurized to 10.0 psig each, and vented to 5.0 for the LOX tank and 1.0 psig for the LH_2 tank.

The LOX and LH_2 tanks were then pressurized to 10.0 psig each for the leak checks, and gas samples were taken to verify that the helium gas concentration in the tanks was 50 percent or greater. During the leak checks, the LOX and LH_2 tank pressure gauges were monitored to verify that there was no pressure decrease greater than 0.5 psig. Leak checks were conducted on the LOX and LH_2 tank systems, including all valves, lines, and feed throughs, using a USON detector set for a sensitivity of 0.001 cubic centimeters per second. Seal leakage measurements were also made, using a flowmeter. The seal leakage at the LOX and LH_2 fill and drain valves, prevalves, relief valves, vent and relief valves, and chilldown pumps, and at the LH_2 directional control valve, were all within the acceptable limits, as was the leakage at the bleed valve sample port.

The leak checks located six areas where the leakage exceeded the 0.001 cubic centimeters per second limits, and FARR A257924 was written to cover these problems. The LOX vent elbow, P/N 1A59434-501; the propellant utilization probe, P/N 1A48430-501-011, S/N D8; the LH_2 fill assembly, P/N 1A78053-1; the LH_2 vent duct, P/N 1A94469-503; and the vent duct bellows assembly, P/N 1A49985 -501, all leaked at their seal leak check ports. These leaks were all satisfactorily corrected by replacing the conoseals. The remaining leakage was around the perimeter seal of the LH_2 tank cover plate, P/N 1A39296-403. This leakage was accepted for use for the completion of the test, with a new seal to be installed at STC.

4.3 (Continued)

After the correction of the leakage problems, the leak check was repeated and satisfactorily completed. The tanks were then vented to ambient pressure and all PTE connections and adapters were removed. The required protective covers and desiccants were installed, and the stage was prepared for removal from the tower for painting and final inspection.

Other than the noted leakages, no particular problems were encountered during the test, and only the one noted FARR, A257924, was written. One revision was made to the procedure to repeat the preparations for the preliminary leak checks and to add two steps to this preparation. This was to permit the repair of a minor leak in a PTE flex cable.

SECTION 5

POSTRETENTION

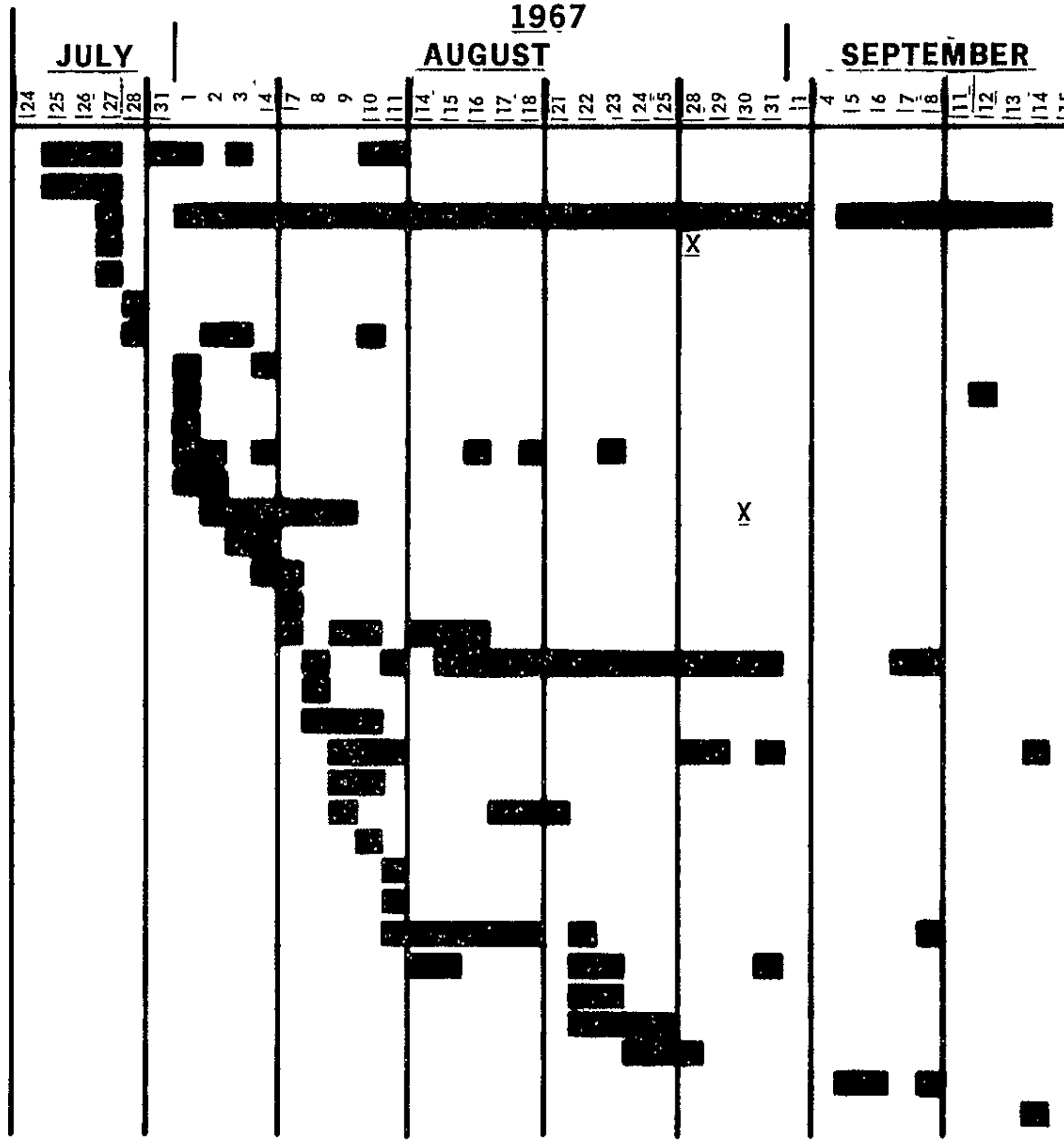
5.0 POSTRETENTION

This section to be added 21 days after stage shipment from SSC to STC.

APPENDIX I

TESTING SEQUENCE

212 SSC VCL TESTING SEQUENCE



PARA		PROCEDURE
4.2.1	1B59763	CONT COMPAT CHK
4.2.2	1B41926	FWD SKIRT T/C SYS C/O
4.2.3	1B42124	FWD SKIRT T/C SYS OPER
4.2.4	1B39095	ENGINE ALIGNMENT
4.2.5	1B64678	CRYO TEMP SENSOR VERIF
4.2.6	1B40544	AFT SKIRT & INTERST PURGE
4.2.7	1B64679	T/M & RS ANTENNA SYS
4.2.8	1B59768	UMBILICAL INTERFACE COMPAT
4.2.9	1B59590	STAGE POWER SETUP
4.2.10	1B59591	STAGE POWER TURNOFF
4.2.11	1B64681	SIGNAL COND CALIB
4.2.12	1B64680	LEVEL SENS & CONT UNIT CALIB
4.2.13	1B59593	DDAS CALIB
4.2.14	1B66929	PROP COMP INT LEAK CHK
4.2.15	1B59429	FUEL TANK PRESS. SYS LEAK CHK
4.2.16	1B59427	PROP SYS CONT CONSOLE MAN
4.2.17	1B59430	PNEU CONT SYS LEAK CHK
4.2.18	1B59594	DIG DATA ACQUIS SYS
4.2.19	1B59592	PWR DISTRIBUTION SYS
4.2.20	1B59431	COLD HE SYS LEAK CHK
4.2.21	1B40973	HYD SYS FILL, FLUSH, BLEED
4.2.22	1B59826	PU SYS CALIB
4.2.23	1B59432	PROP TANK SYS LEAK CHK
4.2.24	1B59481	PROP UTIL SYS
4.2.25	1B59597	EXPLODING BRIDGEWIRE SYS
4.2.26	1B59601	AUX PROPULSION SYS
4.2.27	1B59433	J-2 ENGINE SYS LEAK CHK
4.2.28	1B59485	HYDRAULIC SYS
4.2.29	1B59596	RANGE SAF REC CHK
4.2.30	1B64390	PROPULSION SYS
4.2.31	1B59482	RANGE SAFETY SYS
4.2.32	1B65533	ALL SYSTEMS
4.2.33	1B62965	FWD SKIRT T/C SYS POST-CHK

X INDICATES SECOND ISSUE

APPENDIX II

TABLES

TABLE I. FAILURE AND REJECTION REPORTS, STRUCTURAL ASSEMBLIES

Section I. Propellant Tank Assembly, P/N 1A39303-537

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A233612 12-28-66	The aft ring assembly, P/N 1A39306-33, S/N 2012, had a 1/2 in. wide by 1/8 in. deep gouge in the forward outboard radius, 44 in. clockwise from seam 6.	The gouged surface was smoothed out to an acceptable finish, going no deeper than the existing damage.
A233761 2-7-67	During the preparation of tensile coupon 3 for the propellant tank weld, per A652-1A39303-1PDS1-AD33, welding wire spool, S/N A3-0068, used on the outside weld, was not porosity free and was type B rather than type A wire; the shielding gas manifold was moved from one bottle six pack to another without being re-cleaned; and assembly personnel did not wear clean nylon gloves during manifold installation. All of these were in violation of DPS 14052.	Acceptable to Engineering for use.
A243957 3-1-67	X-ray 67-72 of the forward dome to cylinder inside weld showed a line eminating from the set up line, 24-1/2 in. from dome seam 2 towards seam 3.	Acceptable to Engineering for use.
A243985 4-3-67	Eight studs, P/N S077A428-7, were installed in the LH_2 tank using the wrong locating tool. A 61-1/2 in. dimension should have been 35-1/2 in., and a 35-1/2 in. dimension should have been 11-1/2 in.	Four studs were removed, two from each side of a pattern of four, leaving four studs in the center. The studs were removed by spotfacing flush to 0.010 in. high. The rework was acceptable.

TABLE I, Section 1 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A243986 4-5-67	Two studs, P/N S0717A428-7, were broken from the inside of LH_2 tank center segment 6, 14 in. from weld seam 6, 51 in. aft of the forward circumferential weld scan. The studs attached a bracket, P/N 1B37356-1.	The old weld material was removed by spotfacing, and new studs were installed per DPS 14170. The rework was acceptable when test studs were torqued to 75, 65, and 75 in.-lbs., meeting the 50 in.-lbs. minimum torque requirement.
A243987 4-12-67	The resin used for gap filler and glass liner impregnation on forward dome segments 1 and 2 was processed per DPS 32330 rather than DPS 23003 as required.	Acceptable to Engineering for use.
A243989 4-29-67	Three tile tension block specimens failed to meet the DPS 23003 minimum strength requirements of 150 psi average and no values below 100 psi. Tile specimen 2, for forward dome segment 2, was 45 psi minimum; tile specimen 15, for cylinder segment 1, was 28 psi average and 22 psi minimum; and tile specimen 20, for cylinder segment 5, was 120 psi average and 84 psi minimum.	Forward dome segment 2 was acceptable to Engineering for use. At seven random areas on each of cylindrical tank segments 1, 5, and 2 (as a control), a 2 in. diameter area of liner was removed and 1-1/2 in. diameter plugs were pulled from the tile to test the bond strength. The results of the pull tests were acceptable. The plug test holes were filled with pre-fit tile, gap filler was applied, and glass liner patches were installed. After curing, the rework and bonds were acceptable.
A243990 5-8-67	Inside the LH_2 tank, common dome segment 9 had 2 cuts, 1/2 in. by 3/4 in. by 0.002 in. deep, 6 in. forward of the "V" block.	The scratches were blended out to a minimum 10 to 1 radius to depth ratio, and brush coated with alodine. The rework was acceptable.

TABLE I, Section 1 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A248728 4-13-67	Lap shear coupons representing exterior support installations had a 721 psi minimum pull, and a 902 psi average pull. Per DPS 32330, the pull should not have been less then 1000 psi minimum and 900 psi average.	Acceptable to Engineering for use. The T-peel coupons for the same installations were acceptably above the DPS 32330 requirements.
A248731 4-27-67	During bonding operations, the vacuum on the T-peels and coupons was high, 15 to 22 in. Hg., from 4:45 to 5:30 pm on 4/25/67, and low, 6 to 9 in. Hg., from 4:45 to 5:15 pm on 4/26/67. The vacuum should have been 9 to 15 in. Hg., per DPS 32330.	Acceptable to Engineering for use.
A248998 5-25-67	Twenty-four hours after the LOX tank wash and dry operations were completed there was white powder residue adhering to the edges of the clevis end of strut assembly, P/N 1A57514-511, at the attachment to clamp assembly, P/N 1B64596-1, inside the forward end of the LOX tank.	The bolt attaching the clevis end of the strut assembly was removed, and the strut was dropped clear of the structure. The end of the strut and the structure support were hand wiped clean and alodined to an acceptable condition, and the strut was reassembled per B/P.
A248999 5-26-67	On the inside aft area of the LOX tank, the anodized surface of several segments had a total of 20 to 30 green colored splatter shaped areas, 1/8 in. to 3/4 in. in size.	The discolored areas were wiped clean with methylene chloride and accepted for use.
A257956 6-9-67	The upper end of probe assembly, P/N 1A48431 -505-009, was damaged at the universal and sleeve, P/N 973518-1. The Teflon sleeve had 2 notches, 1/4 in. long by 1/8 in. deep, and the edge of the universal had 2 notches 1/16 in. long by 1/32 in. deep.	Maintaining the required cleanliness level, the sleeve edge was smoothed to eliminate sharp edges, and the notches on the universal were blended out to remove protruding and burred material, and touched up with alodine. The rework was accepted for use.

TABLE I, Section 1 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A257957 6-9-67	Two clamps, P/N 198996-1, had several areas of discoloration on the inside surfaces, and one clamp had a 1/64 in. by 1/16 in. gouge on the outside surface face, with raised surface burrs.	The discolorations were wiped with isopropyl alcohol solvent and brush alodined. The gouge was deburred, faired into the adjacent surface, and touched up with brush-on alodine.
A257958 6-12-67	The common dome had a 1/2 in. by 3/4 in. by 0.019 in. deep ding, 19 in. up from the "V" block area of aft dome segment 4.	Acceptable to Engineering for use.

TABLE I (Continued) Section 2. Forward Dome, P/N 1B64442-501

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A237825 12-8-66	Forward dome segment 7, P/N 1B64442-417, S/N 33, had scratches on the exterior anodized surface, running parallel to the horizontal plane between 110 and 167 in. from the forward end. The scratches ranged from 1/2 in. to 24 in. in length, from 1/32 in. to 1/16 in. in width, and to 0.001 in. maximum depth.	The scratches were polished out and bare metal was touched up with primer per DAC specification F-289. The rework was acceptable.
A237853 12-17-66	X-ray 66-B144 showed an irregular setup line at fitting EE on forward dome segment 7, P/N 1B64442-417, S/N 33.	Acceptable to Engineering for use.
A237882 12-27-66	On the inside surface of forward dome segment 2, P/N 1B64442-413, S/N 34, the pad adjacent to the JJ fitting was scratched over a 1/2 in. by 1 in. area, to a maximum 0.006 in. depth. The outside surface of the segment was scratched over a 2-1/2 in. by 10 in. area opposite the JJ fitting, to a maximum 0.002 in. depth.	The scratched areas were blended and polished to an acceptable condition without increasing the depths. On the outside surface only, the bare metal was touched up with alodine per DPS 41410.
A237901 1-5-67	On forward dome segment 2, P/N 1B64442-413, S/N 34, the inside flange of fitting FF had an ovality of 0.014 in., should have been 0.010 in. maximum.	Acceptable to Engineering for use.
A237964 1-20-67	Forward dome segment 3, P/N 1B64442-403, S/N 35, had a tool drag mark on the inside skin surface at the seam 3 trim line, 153 to 169 in. from the forward edge. The maximum net trim line depth was 0.002 in.	All sharp edges were broken, and the tool mark was smoothed to an acceptable condition.

TABLE I, Section 2 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A237984 1-24-67	Visual inspection of the forward dome meridian welds showed:	
	a. Segment 6 had etch splatter over a 6 x 7/8 in. area inside the forward end near seam 6, and scratches over a 7 x 1/2 x 0.001 in. exterior area 65-1/2 in. from the aft end.	a. The etch splatter was acceptable. The sharp edges of the scratches were broken and the area was touched up with primer.
	b. Adjacent to inside weld seam 6, there were 0.002 in. deep pits at 12, 16-1/4, 36-1/4, 45, and 60 in. from the trailing edge.	b. The areas were scraped lightly to remove the indentations.
	c. Segment 7 had a pasajell spot on the outside surface, 55 in. from the trailing edge, 4 in. from seam 6.	c. The area where anodic was removed was touched up with primer.
	d. Inside seam 3 had a 1-1/8 x 0.002 in. scratch, 61-3/8 in. from the aft end.	d. All sharp edges of the scratch were broken.
	e. Inside seam 5 had a 1-1/8 x 0.005 in. scratch, 55 in. from the aft end, and a row of 0.002 in. deep pits and scratches 44-3/4 to 47-1/4 in. from the trailing edge.	e. The sharp edges of all scratches were broken, and the pit areas were scraped lightly to remove the indentations.
	f. Seam 7 had pasajell on the outside anodized surface, 13 in. from the aft end; scratches on the outside surface, 28 to 50 in. from the aft end; and a 1-1/8 x 0.002 in. scratch adjacent to the inside weld, 74 in. from the trailing edge.	f. The area where anodic was removed was touched up with primer, the sharp edges of all scratches were broken, and the outside rework area was touched up with primer.
	g. Inside seam 9 had 2 scratches 0.002 in. deep 16-1/2 in. from the trailing edge; a 1 x 2 x 0.003 in. scratch 46 in. from the trailing edge; and a 1-1/8 x 0.002 in. scratch 55 in. from the trailing edge.	g. The sharp edges of all the scratches were broken.

TABLE I, Section 2 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A238000 1-30-67	The outside flushed surface of forward dome meridian seam 2 had a rough scratched area 0.002 in. deep, 3/8 to 3/4 in. from the flange weld. Also the anodized inside surface of the flange, P/N 1B66049-401, was scratched 0.001 in. deep in intermittent areas from seam 5 to seam 9.	The scratches were smoothed out to an acceptable condition without increasing the depth. The reworked areas were left bare.
A242807 2-1-67	The ovality of the forward dome flange was 0.024 in., should have been 0.022 in. maximum	Acceptable to Engineering for use.

TABLE I (Continued) Section 3. Cylindrical Tank Assembly, P/N 1A39306-509

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A150955 10-16-66	Cylindrical tank segment 2, P/N 1A39306-417, S/N 127, had a 3/16 x 3/16 x 0.010 in. gouge on the inside surface of pad 1, row A, aft of the -2 clevis.	The gouge was blended to a depth of 0.012 in., blended, etched, dye checked, and accepted for use.
A150959 10-18-66	On the helium bottle support fitting installation of cylinder tank segment 2, P/N 1A39306-417, S/N 4, the clevis weld at pad 3, row B, had a 1/32 in. diameter by 0.022 in. deep pit located 3/16 in. aft of the clevis.	The defect was blended out to a 10 to 1 ratio, with a resulting depth of 0.022 in. and a remaining material thickness of 0.233 in., etched, dye checked, and accepted for use.
A151008 10-12-66	X-ray 66-B119 of the clevis welds on cylindrical tank segment, P/N 1A39306-405, S/N 21, showed scattered porosities in clevis' 1, 2, 3, 4, 5, and 6 of row A, and clevis' 1, 2, 3, 4, 5, and 7 of row B. Dyecheck of the same area showed No. 3 porosities at clevis 5 of row A, and clevis 3 of row B.	The scattered porosities shown on X-ray 66-B119 were acceptable for use. The noted No. 3 porosities were ground out, etched, re-dye checked, and accepted for use.
A151018 10-17-66	On the helium bottle support fitting installation on cylindrical tank segment 2, P/N 1A39306-417, S/N 4, dye check of the clevis welds showed No. 3 porosity at clevis 1 of row A, and clevis 3 of row B.	The defects were ground out, etched, dye checked, and accepted for use.
A220250 9-29-66	Cylindrical tank segment 4, P/N 1A39306-27, S/N 34, was previously removed from cylindrical tank assembly, S/N 2011, by FARR A220169, and as a result the land area was 1-1/8 in., with 1/4 in. of weld deposit remaining, making a total land area of 1-3/8 in. including weld.	The skin was trimmed and rechamfered to remove the weld deposit, leaving a straight edge and a 1-1/8 ±1/16 in. land. The resulting trim and chamfer was 0.125 in. rather than 0.182 ±0.005 in. in a 3-1/2 in. land area 3/4 in. forward of the segment aft end. After rework per SEO 1A39306-018A, the segment was accepted for use.

TABLE I, Section 3 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A228488 11-16-66	The aft ring to cylinder inside weld had intermittent grindouts from flush to 0.005 in. below the parent material on the cylinder side, resulting from the removal of intermittent linear dye check indications.	The grindouts were blended to a 10 to 1 ratio, polished, and accepted for use.
A228493 11-22-66	The aft ring to cylinder outside weld had one grindout 0.008 in. below the parent metal over a 3/16 in. diameter, where a greater than No. 3 porosity was removed between seams 6 and 7. Etch and dye check was acceptable.	The area was blended to a 10 to 1 ratio, re-etched and dye checked, and accepted for use.

TABLE I (Continued) Section 4. Liquid Oxygen Tank Assembly, P/N 1A39307-517

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A237904 1-6-67	The inner side of the common bulkhead had three indentations at the aft end, and intermittent nicks, scratches, and gouges on the base leg. The largest indentation was 3/16 in. diameter by 0.015 in. deep, and the intermittent defects were 0.005 in. maximum depth.	The noted indentations were smoothed up without increasing the depth. The intermittent defects were smoothed, and all sharp edges were broken. The reworked areas were acceptable.
A237941 1-16-67	During the bulkhead installation, a 1 in. area at meridian seam 7 at the forward end of the aft dome was machined to 0.177 in. thickness, below the B/P thickness of 0.191 ±0.005 in.	Acceptable to Engineering for use.
A237980 1-23-67	The outside surface of the aft dome was scratched and scuffed in intermittent areas up to 3 in. aft of the forward end, to a maximum depth of 0.002 in., and in anodized areas adjacent to bulkhead attachments, to a maximum depth of 0.001 in.	The scratched areas were smoothed to an acceptable condition, and bare areas on the anodized surface were touched up with alodine per DPS 41410.

TABLE I (Continued) Section 5. Common Bulkhead Assembly, P/N 1A39309-501

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A150961 10-19-66	The outside surface of the aft common face had scattered small black spots of discoloration on all segments, and minute pits on segment 7.	Superficial dust and dirt was acceptably wiped off with Douglas No. 15 stripper and clean water, using clean white cloths. The minute pits on segment 7 were acceptable for use.
A220512 8-30-66	On the aft common ring assembly, P/N 1A39286-9, S/N 26, X-ray 66-B104 BM and dye check of the ring seams showed cracks, lack of fusion and No. 3 porosity in seam 1, lack of fusion and cracks in seam 2, and cracks in seam 3.	The defective areas were ground out, rewelded, and accepted for use.
A223461 9-28-66	On the hoist fitting installation on the forward common face ring, P/N 1A39280-405, S/N 33, X-ray 66-B109 showed dense foreign material in the lifting lug 6 weld, and a dye check showed a linear indication in the lifting lug 3 weld. During rework, a 1 in. area of fillet was blended to 1/8 in., should have been 3/16 in. minimum.	The dense foreign material was acceptable for use. The linear indication was ground out and blended. The excessive fillet weld blend out was acceptable for use.
A233904 11-4-66	The ring installation of the forward common bulkhead, P/N 1A39280-401, S/N 2012, had a 0.030 in. deep grindout in the outside weld, 31-3/4 in. from seam 6 toward seam 7. Remaining material thickness was 0.071 in.	The defect area was ground out to a 10 to 1 ratio, smoothed and blended to a depth of 0.030 in., re-dye checked, and accepted for use.

TABLE I, Section 5 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A233954 11-4-66	The inside surface of segment 1 of the forward common face, P/N 1A39280-401, S/N 2012, had a 1/16 x 3/32 x 0.003 in. gouged area, 9 in. from seam 1 toward seam 9, 17-1/2 in. forward of the ring seam. The remaining material thickness was 0.032 in.	The gouged area was smoothed to a depth of 0.005 in., etched, dye checked, and accepted for use.
A233963 11-14-66	The planes and radii check of the center plate installation of the forward common face, P/N 1A39280-501, S/N 2012, showed out-of-tolerance conditions of 0.590 to 0.638 in. at longitudes 120, 130, 140, and 150 degrees on latitude 82 degrees, and at latitude 90 degrees.	Acceptable to Engineering for use.
A237859 12-19-66	Dye check of the common bulkhead seal weld before machining showed a crack 68-3/4 in. from seam 5 toward seam 6, and a crack in the parent metal 81-1/4 in. from seam 2 toward seam 3.	The cracks were ground out to 1/8 x 3/16 x 0.010 in. and 1/8 x 1/4 x 0.030 in., respectively, re-dye checked, and accepted for use.
A237861 12-20-66	The forward face of the common bulkhead assembly had a discoloration spot, scattered weld splatter on segment 6 at seam 5, spots of scattered pasajell adjacent to all meridian weld seams, and numbers baked into segments 2 and 4.	The discoloration was removed by scuff sanding the local area and touching up the area with alodine; the weld splatter was removed; and the pasajell spots were touched up with alodine. All reworks were acceptable for use. The baked in numbers were acceptable for use without rework.

TABLE I (Continued) Section 6. Aft Dome Assembly, P/N 1B63286-501

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A150980 10-26-66	During the aft dome meridian pre-production weld, the helium-argon-oxygen shielding gas mixture had 782 ppm of oxygen, should have had 880 ppm minimum.	Acceptable to Engineering.
A151019 10-18-66	X-ray 66-B125 of the aft dome fitting pre-production weld showed transverse less dense inclusions in the outside weld.	Acceptable to Engineering for use.
A223496 10-11-66	On aft dome segment 1, P/N 1B63286-419, S/N 1, the inside weld of fitting DD was 1/8 to 5/32 in. over a 3/4 in. span, and the inside weld of fitting CC was 5/32 in. over a 1/2 in. span and 1/8 to 5/32 in. over a 1-1/4 in. span. Both welds should have been 3/16 in. per B/P. Also, etch was splattered on the anodized surface over an 8 x 1/2 in. area adjacent to fitting DD, and over a 3-1/2 x 3/8 in. area adjacent to fitting CC.	All noted defects were acceptable to Engineering for use.
A223497 10-11-66	On aft dome segment 8, P/N 1B63286-429, S/N 246, the outside tube surface of fitting GG had intermittent scratches, 3/4 x 1/32 x 0.001 in. maximum, and the outside tube surface of fitting FF had intermittent scratches, 3/4 x 1/32 x 0.002 in. maximum, and a 1/2 x 3/8 x 0.005 in. gouged area.	All of the noted defects were blended out to an acceptable condition.

TABLE I, Section 6 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A233917 11-9-66	X-ray 66-B129 of the LOX chill return fitting CC weld showed voids, a crack, and clusters of porosity.	The noted defects were all ground out and manually rewelded. X-ray 66-B129-R1 of the rework was acceptable. Dye check showed a No. 3 porosity, which was ground out and rewelded. X-ray 66-B129-R2 and a dye check showed the rework was acceptable.
A233918 11-9-66	X-ray 66-B129 of the LH_2 chill return fitting DD weld showed tungsten in the weld. Dye check of the same fitting showed linear indications on the inside weld.	The tungsten deposits were ground out and the linear indications were scraped out. One ground out area was manually rewelded. After additional grind out and blending operations, the rework was acceptable for use.
A233919 11-9-66	X-ray 66-B129 of the LH_2 fill line fitting BB weld showed tungsten, connected porosity, voids, and lack of fusion. Dye check of the same fitting showed linear indications and No. 3 porosity in weld 3.	The noted defects were ground out and manually rewelded twice, resulting in an acceptable condition.
A233920 11-9-66	X-ray 66-B129 of the LH_2 feed line fitting EE weld showed less dense inclusions and voids with tails.	The inclusions were acceptable for use. The voids were ground out and manually rewelded to an acceptable condition.

TABLE I, Section 6 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A233955 11-7-66	The aft dome flange did not meet the required flatness tolerance of 0.025 in. The flatness was 0.017 in. at seam 1, tapering to 0.045 in. midway between seams 1 and 2, 0.042 in. at seam 2, and 0.023 in. midway between seams 2 and 3.	Acceptable to Engineering for use. The gap was reduced to less than 0.010 in. when 2 bolts, located about 10 in. apart on the check fixture, were tightened.
A233962 11-14-66	At eight locations around the aft dome jamb, the inside dome surface was uneven. The legs of the stud welding gun rode the jamb weld bead and would not seat firmly for stud installation.	The weld bead was shaved or scraped flush in local areas, sufficient to allow the stud welder to seat where required. The reworked areas were etched, dye checked, and accepted for use.
A233968 11-16-66	A planes and radii check of the aft dome showed out-of-tolerance conditions between longitudes 100 and 200 degrees at latitude 82 degrees. Readings varied from -0.036 to -0.083 in. with an 18 reading average of -0.155 in., should have been -0.100 to -0.400 in. with an average of -0.190 to -0.310 in. Also, fitting CC had a dimension difference of 0.098 in. that should have been 0.051 in. maximum, and latitude 50 degrees had an 18 reading average of +0.075 in., and should have been ±0.060 in.	All out-of-tolerance conditions were acceptable to Engineering for use.

TABLE I (Continued) Section 7. Forward Skirt Assembly, P/N 1B29835-503

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A248771 5-17-67	On branched wire harness 410W201, P/N 1B58139-1, S/N 2165, pins 8, 9, and 11 of connector P12, P/N 1B37872-513, failed the depth check required by WRO-SIVB-3348. The tip of the center contacts were respectively 0.083, 0.047, and 0.087 in. from the end of the contact body, should have been 0.065 ±0.015 in. per DPS 54002-10.	Pin 9 was acceptable to Engineering for use. The coaxial contact assemblies at pins 8 and 11 were removed and replaced. This rework was acceptable for use.

TABLE I (Continued) Section 8. Aft Skirt Assembly, P/N 1B29825-509

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A243688 2-17-67	On the aft skirt web assembly, P/N 1B29831-401, S/N 10, a 1.125 in. diameter hole was cut in the web, P/N 1B29831-3, and through the doubler, P/N 1B29831-61. The hole diameter should have been 0.937 in.	Acceptable to Engineering for use.
A248774 5-24-67	Ground plate assembly, P/N 1B38018-505, was mislocated 4-1/4 in. from stringer 18A. The location should have been 1/4 in. from the stringer 18A centerline.	The ground plate assembly was removed and relocated per B/P, using B/P size rivets, type MS20470AD. The rework was acceptable.
A248806 3-30-67	At stringers 60 and 61, station 240, 6 rivets through angles, P/N 1B29831-19 and -25, and splices, P/N 1B29831-39 and -49, had short edge distances of 1/4 in., should have been 3/8 in.	Acceptable to Engineering for use.
A257508 5-31-67	A bused contact, P/N D105-1100, was removed from W&S connector P1 because of damage in the wire. The contact was crimped and could not be used again for installation purposes per DPS 54002-21.	Not acceptable to Engineering for use. The contact was replaced.

TABLE I (Continued) Section 9. Thrust Structure Assembly, P/N 1A39316-521

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A248807 3-30-67	At the aft ends of stringers 20 and 23, 4 huckbolt holes and 2 hi-lock holes on skin, P/N 1A68951-1, had short edge distances of 0.531 and 0.562 in.; and at the aft end of stringer 8, 3 huckbolt holes on skin, P/N 1A68666-1, had short edge distances of 0.468 in. The edge distances should have been 0.625 in. when the 0.371 to 0.373 in. holes were drilled.	Acceptable to Engineering for use.
A248821 4-6-67	Ring frame assembly, P/N 1A67839-503, had 78 drill marks, 0.010 to 0.030 in. deep, in the surface of the 0.081 in. thick material; ring frame assembly, P/N 1A67503-503, had 26 drill marks, 0.006 to 0.025 in. deep, in the surface of the 0.081 in. thick material; and ring frame assembly, P/N 1A68381-1, had 14 drill marks, 0.005 to 0.030 in. deep, in the surface.	All drill marks were polished per DPS 40160. A No. 30 hole was drilled to remove the deepest portion of each drill mark, and plug rivets, type MS20426AD4, were installed, with no plug rivet closer than 1/2 in. to any existing attachment or any other plug rivet. The rework was acceptable.

TABLE I, Section 9 (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A248924 4-19-67	a. Skin, P/N 1A68349-1, was 0.157 in. thick, should have been 0.250 in. thick, at the forward door frame at stringers 13 to 16, causing excessive mismatch with adjacent skins.	a. A 3/4 x 1-3/4 x 0.125 in. tapered shim was made from spacer, P/N 1A39316-17, and installed to fill the gap between the skin and the frame, picking up 2 existing fasteners.
	b. Stringer 13, P/N 1B28968-901, was only milled to 2-7/8 in. at the forward end, should have been milled to 3-1/8 in., and the radius of the chemical mill rode the edge of the cap angle.	b. A spacer, P/N 1A39316-17, was installed between the stringer and skin, picking up 6 existing attachments. A 2 x 3 x 0.071 in. 7075-T6 aluminum filler was installed to fill the gap between the stringer and the forward attach angle, picking up 8 existing attachments.
		The reworks were alodined, primed, and accepted for use.

TABLE I, Section 9 (Continued)

A248928 4-20-67	a. Skin, P/N 1A68349-501, was installed where skin, P/N 1A68349-1, should have been, and vice-versa. The chemical milling was not the same, there was no hole in the -1 skin for bracket, P/N 1B39841-25, and there was an extra hole in the -501 skin.	a. A 3 in. hole was added to the -1 skin, dimensionally identical to existing hole in the -501 skin. The extra hole in the -501 skin was acceptable. Spacers and doublers were installed per SEO 1A68349-001B, alodined, and primed.
	b. Skin, P/N 1A68549-1, was installed where skin, P/N 1A68549-501, should have been. The -1 skin was chemically milled to 0.032 in. instead of 0.090 in., and a 2-1/4 in. hole was was omitted.	b. A 2-1/4 in. hole was added to the -1 skin, dimensionally identical to the hole in the -501 skin. A doubler was installed on the inboard side of the -1 skin, identical in size and location to the chemically milled pad on the -501 skin, and was alodined and primed. Both reworks were acceptable.

TABLE II. PERMANENT NONCONFORMANCES AND FUNCTIONAL FAILURE AND REJECTION REPORTS DURING STAGE SYSTEM CHECKOUTS

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A248687 8-2-67	Control unit 404A72A5, P/N 1A68710-511, S/N C10, measured 0.89 picofarads, should have measured 1.3 to 1.7 picofarads. Defect noted during the level sensor and control unit calibration, H&CO 1B64680.	The defective unit was removed and a new control unit, S/N C44, was installed and accepted for use. The malfunction of control unit, S/N C10, was confirmed by a retest, and the unit was returned to the vendor for rework or replacement.
A248688 8-3-67	The PCM/DDAS assembly, P/N 1A74049-511, S/N 19, had a VCO output frequency of 594.685 kHz. The frequency should have been between 556.8 and 576.8 kHz. The defect was noted during the DDAS calibration, H&CO 1B59593.	After bench testing and retesting on the stage, it was determined that the VCO would operate properly only with a capacitive load. The assembly was reconfigurated to a Model 301 PCM/DDAS assembly, P/N 1B52720-501, for resubmittal and return to the vendor. A new PCM/DDAS assembly, P/N 1A74049-511, S/N 17, was installed in the stage.
A248690 8-4-67	The PCM/DDAS assembly, P/N 1A74049-511, S/N 17, had a VCO output of 2.15 vrms, should have been 2.2 vrms minimum. Defect noted during the DDAS calibration procedure, H&CO 1B59593.	The PCM/DDAS assembly was removed from the stage and retested. The VCO voltage regulator was adjusted to bring the output amplitude up to the required level. Retesting was acceptable. The PCM/DDAS assembly, S/N 17, was reinstalled on stage 2012, retested per H&CO 1B59593, and accepted for use.

TABLE II (Continued)

<table>
<tr><th>FARR NO.</th><th>DESCRIPTION OF DEFECTS</th><th>DISPOSITION</th></tr>
<tr><td>A248691
8-4-67</td><td>Inspection showed various nicked, out-of-round, and pinched pins, wire insulation damage, and backshell damage at connectors of the following pressure transducers:
<table>
<tr><th>P/N</th><th>S/N</th><th>Ref. Loc.</th><th>Amp. S/N</th><th>Sensor S/N</th></tr>
<tr><td>1B40242-545</td><td>545-12</td><td>403MT708</td><td>13</td><td>184</td></tr>
<tr><td>1B40242-533</td><td>533-34</td><td>403MT709</td><td>298</td><td>496</td></tr>
<tr><td>1B40242-523</td><td>523-4</td><td>410MT600</td><td>6</td><td>110</td></tr>
<tr><td>1B40242-555</td><td>555-4</td><td>409MT650</td><td>341</td><td>36</td></tr>
<tr><td>1B40242-517</td><td>517-9</td><td>403MT670</td><td>220</td><td>101</td></tr>
<tr><td>1B40242-533</td><td>533-39</td><td>403MT754</td><td>300</td><td>490</td></tr>
<tr><td>1B40242-505</td><td>505-25</td><td>409MT651</td><td>332</td><td>215</td></tr>
</table></td><td>The defective connectors were removed and replaced, maintaining maximum cable lengths. The replacement connectors were megohmeter and continuity checked, and accepted for use.</td></tr>
<tr><td>A248692
8-4-67</td><td>On the aft umbilical disconnect panel, the disconnect, P/N 7851861-1, S/N 56, had several lateral nicks in the pipe assembly flare seating surface on the outlet side of the disconnect fitting, and a 0.070 by 0.020 in. nick in the leading edge of the disconnect fitting inlet side. Defect noted during the fuel tank pressurization system leak check, H&CO 1B59429.</td><td>The seating surfaces of the disconnect were refinished to an acceptable condition.</td></tr>
<tr><td>A248693
8-8-67</td><td>The remote analog submultiplexer 404A60A201, P/N 1B54062-503, S/N 42, would not synchronize on channels DP1B0-17 through DP1B0-19 with 28.0 ±2.0 vdc power applied. Defect noted during the DDAS automatic procedure, H&CO 1B59594.</td><td>After retest confirmed the problem, unit, S/N 42, was removed, and another submultiplexer, S/N 41, was installed, tested, and accepted for use. The defective submultiplexer, S/N 42, was reworked to an acceptable condition.</td></tr>
</table>

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A248694 8-9-67	The pneumatic power control module assembly, P/N 1B43657-509, S/N 16, had a lockup pressure of 590 psig, should have been 550 psig maximum. The flow after lockup exceeded 10,000 scim, should have been 25 scim maximum. Defect noted during the pneumatic control system leak check, H&CO 1B59430.	The unit was to be replaced, but was retained for test use until a replacement was available. Reference FARR A261314.
A248695 8-9-67	The static inverter-converter, P/N 1A66212-507, S/N 18, had a V/P excitation of 51.1 vdc, a 117 vdc output of 122.59 vdc, and a frequency monitor output of 406.6 Hz. These should have been 48.0 to 51.0 vdc, 115.0 to 122.5 vdc, and 400 ±6 Hz, respectively. Defects noted during the PU system calibration procedure, H&CO 1B59826.	The inverter-converter was removed and a new unit, P/N 1A66212-507, S/N 29, was installed. Trouble-shooting of S/N 18 showed that module, P/N 1A66224-1, S/N 75, was defective. This component was replaced, and the static inverter-converter, S/N 18, was retested and accepted for further use.
A248696 8-9-67	The gain control of dc amplifier 404A62A208, P/N 1A82395-1, S/N 2389, for measurement C169, could not be adjusted for the required 4.000 ±0.005 vdc output. The maximum attainable output was 3.402 vdc. Defect noted during the DDAS automatic procedure, H&CO 1B59594.	The amplifier was removed and a new unit, P/N 1A82395-1, S/N 2274, was installed at 404A62A208. Retest of S/N 2389 confirmed the defect, and the unit was returned to the vendor for rework or replacement.
A248698 8-10-67	On the thrust structure, orifice fitting, P/N 1B63046-515, between pipe assemblies, P/N's 1B64131-1 and 1B64137-1, had circumferential and vertical scratches on the fitting sealing surface, causing leakage. Defect noted during the cold helium system leak check, H&CO 1B59431.	A new orifice was installed in the stage. Disposition of the damaged orifice was pending at the time of stage storage. Reference Section 5.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A248699 8-11-67	The 6 in. minimum bend radius requirement for hose assembly, P/N 1B63006-1, S/N 07380H100061, was exceeded at 3 in. from the downstream flared end. Defect noted during the hydraulic system fill, flush, and bleed procedure, H&CO 1B40973.	Not acceptable to Engineering for use. The hose assembly was removed and replaced by a new assembly.
A248700 8-11-67	Hose assembly, P/N 1B63071-1, S/N 07380H800030, was kinked 3 in. from the upstream flared end. Defect noted during the hydraulic system fill, flush, and bleed procedure, H&CO 1B40973.	Not acceptable to Engineering for use. The hose assembly was removed and replaced by a new assembly.
A257923 9-20-67	The 3D tile and glass liner inside the LH_2 tank did not conform to WRO S4B-3802 and showed abnormal appearances 22 places on forward dome, 250 places on cylinder segments, and 9 places on aft dome. A reinspection per Engineering request to requirements of SEO 1A39314-004 showed abnormal conditions 13 places on the forward dome and 80 placed on the cylinder segments.	The delaminations at cylinder segment 1 were repaired by injecting resin per DPS 23003 and curing at ambient temperature. The rework was acceptable for use. All other defects were acceptable to Engineering without rework.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A257924 9-25-67	During the propellant tank system leak test, A659-1B65763-1PATP6, the following areas exceeded the 0.001 cubic centimeter per second leakage limit: a. The leak port of elbow, P/N 1A59434-501, on the aft dome. b. The leak port of PU probe, P/N 1A48430-501 -011, S/N D8, on the aft dome. c. The leak port of fill assembly, P/N 1A78053-1, inside the aft skirt. d. The downstream leak port of duct, P/N 1A94469-503, on the forward dome. e. The upstream leak port of bellows assembly, P/N 1A49985-501, on the forward skirt. f. The perimeter of the LH_2 tank cover plate, P/N 1A39296-403.	a, b, c, d, and e. The leaking conoseals were removed and replaced. Retest showed no further leakage and the rework was accepted for use. f. The existing leakage was acceptable to Engineering for the completion of testing. A new cover seal will be installed at STC.
A261125 10-2-67	At station 230 between stringers 6 and 7 on the outboard aft skirt, the bellows of pipe assembly, P/N 1B38529-1, was preloaded to an angulation of 3 deg. 40 min., exceeding the maximum angulation of 1 deg. 30 min. Defect noted during final inspection.	The duct couplings were loosened, and the duct was rotated to remove the preload. New seals were installed at the couplings. The rework removed the discrepancy and was acceptable for use.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261292 7-11-67	Two support assemblies, P/N 1B31140-1, were mislocated 1-1/2 in. each, impeding the installation of piping support hardware.	Four angle doublers were fabricated to nest over the bracket, P/N 1B31140-5, and two doublers were installed over each mislocated support so that the overhang provided mounting surfaces for the piping support hardware. After zinc chromate priming, the rework was accepted for use.
A261293 7-25-67	Panel, P/N 1B55688-503, S/N 39, was not tested per drawing 1B32663 after module, P/N 1A82274-583, S/N 2745, was removed and replaced by module, P/N 1A82274-583, S/N 3192.	Testing was accomplished during VCL checkout by revision 1 to the signal conditioning setup procedure, H&CO 1B64681.
A261303 8-28-67	On pitch hydraulic actuator, P/N 1A66248-507-012A, S/N 65, both halves of the mid-stroke lock, P/N 131-29985, S/N 61, were burred on the forward edge, and the inside of the locking groove of piston assembly, P/N 130-42827-1, was scored and marked by these burrs. Defect noted during the hydraulic system fill, flush, and bleed procedure, H&CO 1B40973.	The burrs were blended off, and inspection showed no further damage. The rework was acceptable for use.
A261305 8-29-67	Multiplexer assembly 404A61A201, P/N 1B62513-533, S/N 16, had an output voltage of 2.7 vdc on sub-channel 10 of channel 28, should have been 5.000 ±0.030 vdc. Defect noted during stage power setup per H&CO 1B59590.	The defective multiplexer was reconfigurated to P/N 1B52715-505, and resubmitted for repair. A new multiplexer, P/N 1B62513-551, S/N 20, was installed and tested by the second issue of the DDAS calibration procedure, H&CO 1B59593.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261306 8-31-67	Channel calibration decoder assembly 404A62A214, P/N 1A74053-503, S/N 305, for the cold helium sphere temperature, measurement C208, did not change from an ambient reading during a high RACS calibration. The high calibration reading was 5.122 vdc, should have been 4.000 ±0.074 vdc. Defect noted during the DDAS automatic procedure, H&CO 1B59594.	The defective unit was removed, and a new channel calibration decoder assembly, P/N 1A74053-503, S/N 360, was installed at 404A62A214. Decoder assembly, S/N 305, was retested and the defect was confirmed. The unit was to be reworked to applicable B/P specifications, or replaced.
A261307 9-1-67	On the J-2 engine, P/N 103826, S/N J-2103, the following measurements failed during the DDAS automatic procedure, H&CO 1B59594: a. Thrust chamber pressure, measurement D1. Transducer 4013MTP3, P/N NA5-27412T10T, S/N 5012A, had a high RACS output of 4.189 vdc, a low RACS output of 1.194 vdc, and an ambient output of 42.881 psia. The outputs should have been 4.056 ±0.100 vdc, 1.055 ±0.100 vdc, and 14.7 ±20.0 psia, respectively. b. GH_2 start bottle pressure, measurement D17. Transducer 4013 MTP5, P/N NA5-27412T15T, S/N 5948A, had a high RACS output of 3.871 vdc, should have been 3.973 ±0.100 vdc. c. Engine regulator outlet pressure, measurement D18. Transducer 4013MTP52, P/N NA5-27412T7LT, S/N 5887A, had a low RACS output of 1.271 vdc, and an ambient output of 30.167 psia. The outputs should have been 1.165 ±0.100 vdc and 14.7 ±15.0 psia respectively.	The defective transducers were removed, and replacement transducers were installed, tested, and accepted for use.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261309 8-11-67	At the downstream end of pipe assembly, P/N 1B58807-1, a 0.070 by 0.021 by 0.0007 in. deep circumferential gouge in the dual fitting seating surface caused leakage at the 1 in. line attachment point. Defect noted during the cold helium system leak check, H&CO 1B59431.	The seating surface was circular polished to meet the finish requirements of MC172, removing no more material than was required. The pipe assembly was cleaned per DPS 43000, packaged per DPS 62180, and accepted for use.
A261310 8-11-67	Pressure transducer 410MT614, P/N 1B43320-601, S/N 44-5, for measurement D178, did not meet the calibration curve within 2 percent of full scale. At ambient pressure, 14.7 psia, the transducer output was 37 percent of full scale, corresponding to 16.73 psia on the calibration curve. Defect noted during the DDAS automatic procedure, H&CO 1B59594.	Transducer, S/N 44-5, was removed, and a new unit, S/N 5-13, was installed for use. Retesting and investigation of S/N 44-5 did not confirm the problem, and the unit was acceptable for further use. The original out-of-tolerance reading was attributed to the presence of gas in the manifold.
A261311 8-14-67	The engine pump purge pneumatic control module assembly, P/N 1B56804-1, S/N 1, had a 22 sccm leakage through the component leak check port, should have been 1 sccm maximum. Defect noted during the pneumatic control system leak check, H&CO 1B59430.	Control module, S/N 1, was removed and a new module, S/N 14, was installed for use. The defective module, S/N 1, was reworked by replacing the gasket and O-ring, with LOX clean conditions maintained. Retest showed that no leakage remained, and the unit was acceptable to Engineering for further use.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261312 8-15-67	Pressure transducer 403MT724, P/N 1B43324-601, S/N 61-1, for measurement D577, read 15.695 psia at ambient pressure, should have been 14.0 $\pm$1.0 psia. Defect noted during the DDAS automatic procedure, H&CO 1B59594.	Transducer, S/N 61-1, was removed, and a new transducer, S/N 60-1, was installed and accepted for use. A retest of transducer, S/N 61-1, showed that the unit met requirements, and it was accepted for future use. It was suspected that pressure in the tank caused the initial out-of-tolerance reading.
A261313 8-16-67	During the J-2 engine system leak check, H&CO 1B59433, the following defects were noted on the J-2 engine, P/N 103826, S/N J-2103: a. On the thrust chamber at the weld upstream of the tee on the line to the main fuel valve open and standby port, pipe assembly, P/N 558268, had a blowing leak at the sleeve weld. b. On the thrust chamber, pipe assembly, P/N 558269, leaked at the weld between the main fuel valve and the start tank discharge solenoid. c. Valve assembly, P/N 557998, S/N 4089018, leaked at the bottom plug on the valve seal, and at the flange to the bottle plug on the start tank sphere.	Rocketdyne personnel repaired the sleeve, rewelded the leaking welds, and replaced the leaking seals. The rework was acceptable for use.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261314 8-16-67	The pneumatic power control module assembly, P/N 1B43657-509, S/N 16, had a lockup pressure of 590 psig, should have been 550 psig maximum. The flow after lockup exceeded 10,000 scim, should have been 25 scim maximum. Defect noted during the pneumatic control system leak check, H&CO 1B59430.	Control module, S/N 16, was removed and a new module, S/N 1029, was installed, tested, and accepted for use. Disposition of the defective module was pending at the time of stage storage. Reference section 5.
A261315 8-17-67	The 5 volt excitation module, P/N 1A77310-505, S/N 118, would not stay adjusted for 5.000 ±0.005 vdc, but drifted 10 to 20 millivolts out-of-tolerance within 30 minutes. Defect noted during the DDAS automatic checkout procedure, H&CO 1B59594.	Module, S/N 118, was replaced by a new module, S/N 161. Retesting of S/N 118 confirmed the problem and the unit was scrapped.
A261316 8-18-67	The output of channel calibration command decoder assembly 411A61A216, P/N 1A74053-503, S/N 344, had random failures during RACS tests. Defect noted during the DDAS automatic procedure, H&CO 1B59594.	The defective unit was removed, and a new channel calibration command decoder, P/N 1A74053-503, S/N 340, was installed at 411A61A216. Decoder assembly, S/N 344, was retested and the defect was confirmed. The unit was to be reworked to applicable B/P specifications, or replaced.
A261317 8-18-67	On relay module 411A99A10A11, P/N 1A74211-505, S/N 405, contact K-18-2 indicated "open" with forward bus 2 energized. Test point pin H in relay receptacle J-3 indicated zero volts, should have been 28 ±2 vdc. Defect noted during the stage power setup procedure, H&CO 1B59590.	The module was removed and a new module, S/N 438, was installed. Retesting of S/N 405 confirmed the defect and the module was scrapped.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261318 8-21-67	Transducer kit 404MT628, P/N 1B40242-501, S/N 501-20, measured -0.300 vdc, should have measured about 3.000 vdc. The transducer cable and the vehicle cable were found to have been crossed during installation of the transducer amplifier. Defect noted during the DDAS automatic checkout, H&CO 1B59594.	Transducer kit, S/N 501-20, was removed, and a new transducer kit, S/N 501-22, was installed. (Reference FARR A261323). Disposition of the defective transducer kit, S/N 501-20, was pending at the time of stage storage. Reference section 5.
A261320 8-23-67	A damaged pin was discovered on connector, P/N DTK06-12-10S, during a re-inspection per WRO S4B-3714.	All pins on the connector were removed and replaced per DPS 54002-10. The rework was acceptable for use.
A261322 8-24-67	Transducer kit, P/N 1B40242-555, S/N 555-14, on multiplexer channel DP1-B0-01-09, had a low RACS output of 0.005 vdc, should have been 1.000 ±0.100 vdc. The matched transducer set consisted of transducer, P/N 1B40242-11, S/N 36, amplifier, P/N 1B40242-3, S/N 341, and cable, P/N 1B40242-67, S/N 555-14. Defect noted during the DDAS automatic checkout, H&CO 1B59594.	The components of the defective transducer kit were removed, and transducer kit, S/N 555-24, was installed and accepted for use. A retest of transducer kit, S/N 555-14, confirmed the defect, and the kit was returned to the vendor for rework or replacement.
A261323 8-25-67	Transducer kit, P/N 1B40242-501, S/N 501-22, for common bulkhead pressure measurement D545, had a high RACS command output of 0.024 vdc, should have been 4.000 ±0.100 vdc. The matched transducer kit consisted of transducer, P/N 1B40242-5, S/N 340, amplifier, P/N 1B40242-3, S/N 323, and cable, P/N 1B40242-59, S/N 501-22. Defect noted during the DDAS automatic checkout, H&CO 1B59594.	Bench test of the transducer kit per procedure A659-1B40242-1-PATP1 was acceptable. However, since the kit was previously rejected from stage 505N for the same problem, and since operation was marginal and intermittent, the kit was not acceptable to Engineering and was to be replaced. A new transducer kit, S/N 501-25, was installed at 404MT628.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261324 8-25-67	The pitch hydraulic actuator, P/N 1A66248-507 -012, S/N 66, was suspected to leak oil past the actuator piston seal. The hydraulic pressure dropped to 3310 psia, below the allowable minimum pressure of 3310.06 to 3400 psia. Defect noted during the hydraulic system automatic checkout, H&CO 1B59485.	Actuator, S/N 66, was removed, and a new actuator, S/N 65, was installed, tested, and accepted for use. It was found that actuator, S/N 66, was rejected in error, as no leakage existed. A blown fuse in the GSE function generator had caused the computer to shutdown, not low oil pressure. The actuator was retested per 1B88230, checked for cleanliness per DPS 43801, packaged per DPS 62161, and placed in stock as acceptable for future use.
A261325 9-7-67	Channel decoder assembly 404A72A200, P/N 1A74053-503, S/N 233, had an output on all channels during high and low RACS test 5 of channel 19. There should not have been an output on any channel. Defect noted during the all systems procedure, H&CO 1B65533.	Decoder assembly, S/N 233, was replaced by S/N 331 for use. Retest of S/N 233 showed that line voltage spikes caused erroneous logic changes. The defective unit was returned to the vendor for rework or replacement.
A261457 7-31-67	At the forward skirt vent valve, on wire harness 411W6, P/N 1B65945-1, connector P14, P/N 4966DTK06-14-19S-3005, and connectors, P17 and P18, P/N's 4966DTK06-12-10S-3005, had damaged pins, and connectors P14 and P17 were themselves damaged.	Connectors P14, P17, and P18, on wire harness 411W6, were removed and replaced per B/P requirements. The rework was acceptable for use.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A261458 7-31-67	In the aft skirt tunnel area, connector P17, P/N DTK-06-14-19S-3005, on wire harness 403W2, P/N 1B58323-1, had two wires, Q33A22 and Q34A22, damaged at the back end of their pin contact while inserting the wires into the connector.	Connector P17 was removed and replaced on wire harness 403W2 per B/P requirements. The rework was acceptable for use.
A271134 10-19-67	On cannon connector, P/N 1A97494-619, S/N 6543, the socket A locking device was defective and would not retain the contact. (Reference FARR 500-071-036).	Not acceptable to Engineering for use. A new connector was installed on the stage. The defective connector was to be replaced.
A271226 9-14-67	During the all systems test procedure, H&CO 1B65533, twelve measurements exceeded the noise level tolerance requirements of SM-46847, used by the TP&E committee for evaluation of telemetry test data. The noise level should not have exceeded 2 to 5 percent peak-to-peak over 1 second duration. a. The following measurements were affected by chilldown inverter noise, with the noted percent peak-to-peak noise level over 1 second duration:	Disposition pending at time of storage. Reference Section 5.

Meas.	P/N	S/N	Loc.	Percent Noise
D1	NA5-27412T10T	6439A	4013MTP3	2.3
D10	NA5-27412T10T	5059A	4013MTP4	3.0
D18	NA5-27412T7LT	4626A	4014MTP52	2.6
M69	1A77310-505	161	404A75A7	3.0

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
A271226 (Cont.)	b. The following measurements were affected by RFI, with the noted per cent peak-to-peak noise level over 1 second duration:	

Meas.	P/N	S/N	Loc.	Percent Noise
D16	1B40242-565	565-4	425MT601	3.0
D54	1B40242-523	523-4	410MT600	4.0
D160	1B39293-1	131	403MT732	2.7
D184	1B40242-505	505-25	409MT651	3.0
D218	1B53574-501	501-20	403MT750	3.0
N18	1B52721-521 -006	32	411A64A200	7.0
N55	1A74776-503	296	411MT728	18.0
*D576	1B40242-501	501-25	404MT628	4.0

*Hardwire Measurement

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-071-010 9-29-67	During the final inspection, the following aft skirt stringers were noted to have milling damage on the extrusion standing legs. The remaining material thickness (RMT) should have been 0.070 ± 0.007 in. a. Stringer 39 had an RMT of 0.059 in. for a 3 in. length of the full standing leg width, 31 in. from the forward end of the stringer. b. Stringer 41 had an RMT of 0.061 in. for a 36 in. length of the full standing leg width, 28 in. from the forward end of the stringer.	All of the noted conditions were acceptable for use.

TABLE II (Continued)

FARR NO.	DESCRIPTION OF DEFECTS	DISPOSITION
500-071-010 (Cont.)	c. stringer 80 had an RMT of 0.048 in. for a 46 in. length of the full standing leg width, 18 in. from the forward end of the stringer.	
500-071-036 10-17-67	At aft skirt stringer 111, plug P9 of wire harness 404W15, P/N 1B51234-1, had pin A recessed. The pin was pushed down into seating position, but would not seat properly. Defect noted during final inspection.	Connector P9, P/N 1A97494-619 was replaced. (Reference FARR A271134.) Pin A and the associate wire, P40A4, were also replaced, using a longer wire. Pins B, C, and D, and their associated wires, were acceptable with minor scratches on the pin crimp barrels. The rework was acceptable for use.
500-071-265 10-2-67	On the right-hand side of the main tunnel at the aft skirt forward attachment ring, two main tunnel attachment clips, P/N 1A39313-401, were mislocated by 1/4 and 3/8 in. Because of this mislocation, screw holes in cover, P/N 1A39313 -411, were filed out 1/16 in. above B/P tolerance without proper engineering documentation. Also, the main tunnel covers had gaps of 1/8 in. to 7/32 in. at positions 7 and 8, cover, P/N 1A39313 -413, and at positions 10 and 11, cover, P/N 1A39313-145. The gaps should not have exceeded 1/32 in. maximum. Defects noted during the final inspection.	The mislocated attachment clips and filed out screw holes were acceptable for use. The main tunnel covers were replaced, and the new covers were finished per F289 finish specification. Remaining gaps of 1/16 to 3/32 in. were acceptable.
500-071-281 10-24-67	On the LH_2 recirculation duct assembly, P/N 1A49966 -503-003, the vacuum sensor thermocouple connector, G.E. P/N 8651860G5, was corroded and had one prong excessively bent.	The connector was replaced, re-tested, and accepted for use.

FORM NO. 30-846-1 (9-65)

DOUGLAS

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